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REVIEW AND INVESTIGATION TO ADDRESS SPECIFIC
TECHNICAL ISSUES RAISED DURING THE SITE ASSIGNMENT
EVALUATION FOR THE OGDEN HAVERHILL FACILITY IN
HAVERHILL, MASSACHUSETTS

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ABSTRACT

This report addresses specific technical issues concerning the Ogden Haverhill resource recovery facility at Ward Hill Neck in Haverhill, Massachusetts in accordance to a December 13, 1988 Agreement the City of Haverhill Board of Health, Ogden Haverhill Associates and the Massachusetts Department of Environmental Quality Engineering. The charge of this study was to examine the following:

- TASK 1: Review and Evaluate Stack Emissions Data Used for the Air Quality and Health Risk Assessment for the Ogden Haverhill Facility
- TASK 2: Review and Evaluate Ash Emissions Data and Air Quality Modeling Methodology used for the Haverhill Landfill
- TASK 3: Evaluate the Appropriateness of Logan Airport Meteorological Data
- TASK 4: Review the Previously Conducted Interactive Modeling Study

At the outset of this study, the most outstanding concern to the Board of Health was the overall impact of the facility's operation to public health, safety and the environment as determined by risk assessments performed by technical consultants of Ogden Haverhill Associates and the Board of Health. These risk assessments were determined for key stack emissions from the facility to range from 4 to 14 in a million and from fugitive ash emissions from the adjacent monofill to range from 1 to 190 in a million.

After review and analysis of information contained in a lengthy Hearing Record of transcripts, prepared testimony, briefs, and other technical documents, this study has concluded the following:

- o The maximum total excess lifetime cancer risk due to stack emissions from the Haverhill facility is estimated to range from 2 to 6 in a million.
- o The total excess lifetime cancer risk due to fugitive ash emissions from the monofill located adjacent to the Haverhill facility is estimated to be less than 1 in a million.
- o The Logan Airport meteorological data is appropriate for the stack emissions risk assessment; however, the Logan meteorological data used in the ash risk assessment does not take into account the influence of ground level terrain at the Haverhill Ward Hill Neck site.
- o The interactive modeling conducted for the existing resource recovery facilities in the Merrimack River valley was appropriate; however, a review of the emissions inputs versus actual stack test

data shows differences. Because the risk assessment contained in the Hearing Record has not been corrected by the Ogden Haverhill Associates and Board of Health consultants, extrapolation of the health risk assessment using actual emission data from the resource recovery facilities in the area cannot be made.

The study concludes that the risk ranges from either the stack emissions or the ash disposal activities is within the acceptable range based upon the Board of Health's risk criteria. There are, however, some unresolved issues which contribute to the range variance. If the Board of Health wants to further refine the risk numbers rather than having a range, recommendations have been included in this report for follow-up studies.

EXECUTIVE SUMMARY

In December 1986, Ogden Haverhill Associates (OHA) acquired the rights to construct a resource recovery facility at the Ward Hill Neck site in Haverhill, Massachusetts. At the time of the closing, all necessary local, state, and federal construction permits had been obtained.

The Haverhill Board of Health (hereinafter "the Board") convened a public hearing under M.G.L. c.111, §150A in 1987 to consider whether the site assignment previously granted for a solid waste disposal facility on Ward Hill Neck should be modified, suspended, or revoked. Hearings were conducted under a formal adjudicatory hearing format from June 1987 through April 1988. An extensive Hearing Record (hereafter "the Record") was compiled consisting of hearing transcripts, prepared testimony, briefs, and other documents which were submitted to the Board.

Based upon what it considered to be its statutory authority under M.G.L. c.111, §150A, the Board sought this proceeding to determine whether the proposed OHA facility presents a threat to public health, safety, or the environment. At the conclusion of the public hearing process, the Board had still not resolved five technical issues with respect to the environmental impact of the OHA facility. After extensive negotiations, the Board, OHA, Refuse Fuels Associates (RFA) entered into an Agreement on December 13, 1988 with the Department of Environmental Quality Engineering (DEQE) to refer certain specific issues of concern to DEQE and The Environmental Institute of the University of Massachusetts (UMass) at Amherst for further review and investigation.

A Task Force was created to conduct a review and evaluation to address five technical issues. The Task Force Team included the following:

- (a) Investigative Team consisting of Dr. Salvatore R. DiNardi (UMass, Principal Investigator), Dr. Richard R. Knapp (Summit Environmental Engineering), and Mr. Charles E. Kitson (C.E. Kitson & Associates).
- (b) DEQE Technical Staff consisting of Dr. Andrea Papadopoulos (Office of Research and Standards, Task Order Manager), Mr. Robert T. Donaldson (Division of Air Quality Control), Ms. Carol Rowan West (Director, Office of Research and Standards), Mr. Steven Dennis (Division of Air Quality Control), and Mr. Edward McDonald (Northeast Regional Office).

This report addresses the first four issues as authorized under the Agreement. The fifth task was established to define the need and develop the scope for an on-site and ambient air quality monitoring program and work is currently underway. The Task Force's instructions as given in the December 13, 1988 Agreement and the Task Force's findings and recommendations for the first four technical issues are as follows:

TASK 1: Review and Evaluate Stack Emissions Data Used for the Air Quality and Health Risk Assessment for the Ogden Haverhill Facility.

December 13, 1988 Agreement

"Evaluate OHA's stack emission data used in performing an air health risk assessment by reviewing (1) the Joy/Niro Report and supporting materials on recently concluded dioxin air emission testing of the Zurich Josefstrasse facility, in Zurich, Switzerland; (2) recent dioxin air emission data with respect to the Millbury, Massachusetts mass-burn facility with such technical adjustments as are necessary to ensure that the Millbury data are comparable to the OHA mass burn facility; and (3) any other relevant air emission data as has been collected by DEQE or is otherwise reasonably obtainable by the Task Force."

Task Force's Findings and Recommendations

To determine whether unacceptable risks are likely to occur to the public or the environment due to operation of the proposed OHA facility, the Board requested that OHA prepare an air quality and health risk assessment of the stack emissions from the proposed facility. Lacking specific stack emission data from an existing facility with a dry scrubber/four-field electrostatic precipitators (ESP) that is comparable with the air pollution control technology proposed for the Haverhill facility, OHA extrapolated emission data from an existing facility in Zurich, Switzerland that has been retrofitted with a dry scrubber. To estimate trace metal emission rates for the OHA facility, OHA scaled the trace metal weight percentages measured at existing resource recovery facilities by the expected typical particulate emission rate for the OHA facility.

In the initial health risk assessment, OHA used the uncontrolled dioxin/furan (PCDD/PCDF) emissions data from the Zurich Josefstrasse facility with an assumed 76 percent removal efficiency based on stack testing data at another facility. In June 1988, OHA reported that recent (Joy/Niro) tests conducted at the Zurich Josefstrasse facility measured removal efficiency for dioxins/furans greater than 90 percent. At that time, the Board agreed that if the air pollution control system proposed for the OHA facility could achieve a 90 percent removal efficiency, the health risk associated with stack emissions would be significantly reduced.

The Wheelabrator Millbury, Inc. Resource Recovery Facility in Millbury, Massachusetts, which became operational in September 1987, consists of two identical 750 tons per day (TPD) units that are equipped with spray dryer absorber for acid gas removal and a three-field ESP for control of suspended particulate emissions. The Millbury facility is considered the first application of a spray dryer/ESP control system in North America.

The maximum allowable emission rate for particulate matter is 0.030 gr/dscf corrected to 12% CO₂ for the Millbury facility. The proposed OHA facility, with a larger four-field ESP, has an allowable particulate matter emission rate that is 50 percent lower (0.015 gr/dscf corrected to 12% CO₂) than the Millbury facility. The Task Force believes that the OHA facility has a state-of-the-art combustion and air pollution control systems and, if operated and maintained as designed, should result in lower emissions than the Millbury facility. Therefore, after adjusting for the size of each facility, the Millbury stack test data should be considered a conservative estimate of expected stack emissions from the OHA facility.

Based on the similarities of these two facilities and the acceptance by the Board of typical emissions to represent the long-term average emissions in the health risk assessment, the Task Force compared the average Millbury stack pollutant emissions (based on the stack sampling tests) with the stack emissions data used by OHA in the stack health risk assessment.

The average (pollutant-specific) stack emission rates measured at the Millbury facility were scaled to adjust for the capacity differences between the two facilities. The following summarizes the Task Force's conclusions based on the comparison of the average scaled-Millbury emissions data with the emissions data used by OHA in the health risk assessment:

- o With the exception of chromium VI emissions, the trace metal emissions used in the OHA health risk assessment appear to be reasonable based on the comparison with the average scaled-Millbury data.
- o The Millbury stack tests measured only total chromium emissions and did not detect the hexavalent chromium (VI) emission rate. While the chromium VI emission rate used by OHA in their health risk assessment may be achievable with the air pollution control equipment installed at the OHA facility, OHA's assumption that the chromium VI emission rate is less than one-tenth of one percent of the total chromium emission rate is not consistent with other health risk assessment studies and may result in an increase of one in a million risk due to chromium VI emissions.
- o The 2,3,7,8 TCDD toxic equivalents emission rate determined from the Millbury stack data was found to be lower than the emission rate used by OHA in the OHA stack health risk assessment.
- o The spray dryer/ESP control system testing at the Millbury facility measured the removal efficiency of dioxin and furan emissions to be approximately 70 percent. Based on these results, the use of the Zurich Josefstrasse's higher removal efficiency to further reduce the dioxins/furans emissions used in the health risk assessment is not recommended. The tested dioxin/furan emission rates from Millbury are lower than those used in the risk assessment.

The Task Force Agreement specifically defined the work scope to review and evaluate emissions data and other assumptions used in the health risk assessments conducted for the OHA facility. While the December 13, 1988 Agreement does not require an evaluation of the health risk assessment procedures, an attempt has been made to extrapolate the findings of this study to the stack health risk conclusions found in the Record.

The total potential lifetime cancer risks for the maximum exposed individual (MEI) due to the stack emissions from the OHA facility as calculated by OHA and the Board's consultants ranged from approximately four to fourteen in a million. After evaluating the technical differences between the two health risk estimates, the Task Force believes that the maximum total lifetime cancer risk due to the stack emissions would range from approximately two to six in a million.

Taking into consideration all the adjustments as made above, the Task Force concludes the risk from stack emissions range from two to six in a million which is below the acceptable value of ten in a million as established by the Board. There are, however, some unresolved issues which contribute to the range variance. To further refine the risk number rather than except a range, the following information would have to be obtained and technical issues resolved:

- o Stack emissions data for arsenic, chromium VI, and dioxins/furans based on the stack (compliance) tests to be conducted at the OHA facility.
- o Resolution of the deposition modeling approaches for organic pollutants.
- o Verification of the toxic equivalent factors to be used in the calculation of the 2,3,7,8 TCDD toxic equivalents emission rate.

TASK 2: Review and Evaluate Ash Emissions Data and Air Quality Modeling Methodology used for the Haverhill Landfill.

December 13, 1988 Agreement

"Evaluate OHA's ash emission data used in OHA's screening level and refined ash health risk assessments through the use of such actual fugitive emission data as exists in (1) a DEQE databank on ash emissions created in conjunction with the New York State Energy Research and Development Authority and the United States Environmental Protection Agency; (2) ash emission data which may become available to DEQE during the course of this project along with such extrapolation and adjustments as are necessary to render these data comparable to the OHA mass-burn facility including those adjustments necessary to reflect OHA's ash management techniques reflected in a certain Stipulation of Conditions of December 13, 1988 to amend by stipulation the OHA site assignment; and (3) any other data, including data, if any, collected as part of this study as the Task Force shall deem available, comparable and scientifically reliable."

Task Force's Findings and Recommendations

The Task Force determined that the ash data provided by OHA from a soil sampling program conducted at the Marion County Resource Recovery Facility in Oregon and the ambient monitoring data collected at the ash disposal site at the RESCO Saugus (MA) facility could not be converted into pollutant emission rates needed for the air quality and health risk assessment analyses.

With the lack of acceptable empirical data on ash emissions from existing disposal and landfilling operations, the fugitive ash emissions due to the ash handling activities at the OHA facility were estimated based on emission factor equations developed for the U.S. EPA. The fugitive emission factor equations used are based on field tests and provide empirical relationships of emissions based on material properties, handling practices, and environmental factors. The Task Force believes that the fugitive emission rates as calculated by the empirical equations would vary due to a wide range of handling and environmental practices. Therefore, without any acceptable empirical data available and with the extremely small quantities involved, uncertainties remain.

On December 13, 1988, the Board, OHA, and Refuse Fuels Associates signed a Modification of Site Assignment by Stipulation that amended the existing Site Assignment. In the Stipulation of Conditions, OHA agreed to modify its ash management procedures to minimize fugitive ash emissions from the OHA facility. As stated in the Stipulation, all ash handling and disposal activities at the OHA facility shall conform to the following procedures:

- o Ash Handling Building. All systems for handling ash in preparation for transport to the Landfill will be conducted in a single enclosed building, or with the use of enclosed conveyors between buildings. The ash handling building will be designed and configured so that it will be under negative air pressure and the doors of the building will be closed when ash is not being transported. The truck loading area will be elevated so that any ash spilled will not come into contact with truck tires and the floors will be swept clean at the end of each day.
- o Ash Transport Vehicles. All ash transport vehicles disposing of ash at the Landfill, regardless of origin, will be covered with tight fitting covers and the truck beds shall be moisture tight.
- o Ash Landfill Area. Ash will be loaded, transported and landfilled in the early morning and late afternoon and will be covered daily. The working face will be kept to as small a size as is practicable and situated such that transport vehicles will not, to the greatest extent possible, track over uncovered ash. A water truck will be on site at all times to spray roadways to minimize landfill dusting and to prevent ash dusting at the monofill during ash landfilling and covering operations.

- o Ash Moisture Content. Ash in the storage building, transport vehicles, and during landfilling shall be maintained at a moisture content at approximately 20 percent or a level sufficient to minimize ash dusting. Moisture samples shall be taken at the working face and analyzed weekly during the period from June 1 and September 1, and monthly during all other periods.
- o Ash Sources. Only ash from OHA and the Ogden-Lawrence facility ("OHA ash") or other Ogden facilities (if such ash does not pose any greater operational or long-term risk to the public health or the environment than OHA ash) shall be accepted for disposal at the Ward Hill Neck Landfill.

Based on the added control measures proposed by OHA to minimize fugitive ash emissions, the Board's consultants agreed that the fugitive ash emissions from the ash handling building and the ash transport vehicles should be assumed zero for the health risk assessment analysis. Therefore, further evaluation of the empirical equations used for these ash handling activities are not required.

Using these empirical emission factor equations to estimate the fugitive ash emissions for the OHA facility, OHA submitted screening and refined ash health risk assessments during the 1987-1988 period. Based on the screening level assumptions, OHA estimated that the potential lifetime cancer risk was approximately four in a million. The Board's consultants testified that OHA significantly underestimated the particle deposition velocity and made additional errors in their analysis. After correcting for these errors, the Board's consultants estimated that the potential lifetime cancer risk due to fugitive emissions at the OHA facility would be approximately 190 in a million.

The risk estimate of 190 in a million due to fugitive ash emissions has been a major concern to the Board. Even though the Task Force's work scope did not include conducting a revised health risk assessment, the Task Force worked with the technical consultants for both parties in an attempt to reach a closer agreement between the health risk estimates.

After meeting with the Task Force in March 1989 and reviewing additional reports not previously provided to them, the Board's consultants reduced their screening level health risk due to fugitive ash emissions to a range from one to five in a million. At this time, based on the ash management plans proposed by OHA, it appears that both parties agree that the total excess lifetime cancer risks due to fugitive ash emissions at the monofill should be in the one to five in a million range. Additionally, if adjustments are made for reduced oral arsenic potency now approved by U.S. EPA, the total lifetime risk due to fugitive ash emissions should be less than one in a million.

If OHA operates and maintains the ash handling facilities as described in the Stipulation of Conditions, the Task Force expects that the fugitive ash emissions from the monofill area due to truck dumping, landfill maintenance, and wind erosion of the exposed ash surface should be negligible.

In addition, the Task Force has determined the primary reason for the divergent risk estimates to be errors contained and perpetuated inadvertently in the risk assessment analysis and not in the difference in the estimate of the fugitive ash emissions.

As part of the negotiations that led to the Task Force study, OHA agreed to conduct a short-term ambient monitoring program using a sufficient number of particulate samplers spaced around the perimeter of the ash monofill to attempt to quantify the emissions from the monofill activities. The monitoring program must include meteorological measurements and enough monitors to determine the "upwind" and "downwind" concentrations for a given sampling period. The monitoring program should be specifically designed to enable the determination of a pollutant-specific emission rates. A monitoring protocol should be prepared and submitted to the DEQE for approval before start-up.

TASK 3: Evaluate the Appropriateness of Logan Airport Meteorological Data

December 13, 1988 Agreement

"Evaluate the appropriateness of originally using Logan meteorological data in the ash and air health risk assessment's submitted by OHA to the Board in connection with the site assignment hearing by review of available local meteorological data, if any. If sufficient data do not exist for the purposes of this review, then the Task Force shall approve a protocol for monitoring local meteorological conditions to develop short-term data for the purpose of evaluating the use of Logan meteorological data. The Task Force shall perform a sensitivity analysis to describe the scientific significance attendant on any such short-term meteorological study."

Task Force's Findings and Recommendations

An evaluation has been made as to the appropriateness of using five years of Logan Airport data in the air quality modeling analyses. The 1983 Logan Airport data was compared with available local meteorological data from the Lawrence Municipal Airport. The Lawrence Airport data consisted of less than one-half of all possible data hours in 1983 since no observations were recorded for nighttime hours.

The Task Force found that the meteorological conditions of wind speed and direction at the Logan and Lawrence Airports are similar, at least during the hours when concurrent observations were made. Even though the U.S. EPA states that on-site meteorological data (if available) are preferred for use in air quality modeling analyses, the use of a five year off-site data record (instead of a one year on-site data base) allows for a greater number of combinations of meteorological conditions to provide that the "worst-case" conditions might be reflected in the air quality modeling results.

For stack emissions, the Logan Airport meteorological data appear reasonably representative of the Haverhill area. Any differences in meteorological conditions between the OHA site and Logan Airport should not result in significant differences in predicted air quality impacts, considering the length of the meteorological data base employed. The use of five years of meteorological data should provide that the worst-case meteorological conditions for the site were represented.

A modeling study (conducted by OHA at the request of the Task Force) for the ash emission sources at the monofill indicated that the nighttime hours contribute the most to the annual average concentration. For the Spring Hill Farm, Crystal Lake, and the maximum exposed individual (MEI) receptors, the 12-hour nighttime period is responsible for approximately 64 to 78 percent of the total annual average concentrations.

The analysis of the Lawrence Airport data versus Logan Airport data does not conclusively put this issue to rest. As a meteorological program will be required to meet the monitoring requirements of Task 5, the Task Force recommends that this program be of sufficient quality and quantity to be of use in future air quality modeling, as required by DEQE. This program should obtain data representative of the conditions influencing fugitive ash emissions from the monofill as well as as conditions at stack height. The collection of stack-top meteorological data is necessary for use in analyzing the ambient air quality monitoring data to be collected as part of the Task 5 requirements. A meteorological monitoring protocol should be prepared and submitted to the DEQE for review and approval. Under the provisions of M.G.L. c.21H, DEQE requires the emission testing of resource recovery facilities and modeling emissions to determine impacts. The meteorological data obtained in Task 5 should be used in this analysis.

TASK 4: Review the Previously Conducted Interactive Modeling Study.

December 13, 1988 Agreement

"Evaluate the appropriateness of the emissions data used by OHA for the modeling of emissions from the NESWC and Lawrence facilities in the combined ash/air health risk assessment prepared and submitted by OHA to the Board, by evaluation of emissions studies for those facilities prepared for and submitted to DEQE, when those studies have been validated and released by DEQE and information with regard to the mass-burn facility developed under other tasks in this study. Based on a review of actual emissions data, the Task Force may request that additional air quality modeling be conducted by OHA's consultants."

Task Force's Findings and Recommendations

The Task Force reviewed the interactive modeling analyses prepared by OHA for the two other resource recovery facilities identified in the Haverhill area - the Ogden-Lawrence RDF and North Andover NESWC facilities. For

these two facilities, air dispersion models were used to estimate ambient air quality concentrations and deposition rates due to pollutant emissions from each facility. The air quality modeling results were used in risk assessment studies conducted for each facility to estimate the health risk to human receptors.

In order to evaluate the appropriateness of the emissions data and modeling procedures used by OHA for the two existing facilities in the Haverhill area, the pollutant emission rates and stack parameters were compared with recent compliance testing results and facility information obtained from the Massachusetts DEQE.

Specific pollutant emission rates were determined by OHA's consultants for the Ogden-Lawrence and North Andover facilities from available stack sampling data and using scaling factors developed for pollutants for which no test data were available at the time of the study. Based on recent stack sampling tests conducted at both facilities in 1988, the DEQE summarized the results in a format suitable for use in an air quality modeling study.

The stack parameters used in the air quality modeling analyses conducted by OHA for the Lawrence and North Andover facilities were nearly identical to the values determined by the Task Force. Although no computer print-outs of the air quality modeling runs for these two facilities were included in the Record for review and verification, it appears that correct stack parameters were used by OHA for the two existing facilities.

The trace metal emission rates calculated from the recent compliance tests conducted at the existing facilities are, in general, higher than the emission rates used by OHA in the air quality and health risk assessment analyses conducted for each facility. However, the 2,3,7,8 TCDD toxic equivalents emission rates measured by the compliance tests at each facility are less than the emission rates used by OHA in its health risk assessment.

In addition to the differences in the emission rates at the two facilities, the Task Force found that the stack health risk assessment analyses conducted by OHA for the Ogden-Lawrence and North Andover facilities still require resolution on several technical issues. The health risk assessment for the two existing facilities was conducted in late 1987. As with the stack risk assessment for the OHA facility, the Board's consultant disagreed with the approach used and results obtained by OHA's consultants. In particular, the deposition velocities used in the health risk assessment for the existing facilities do not appear to be consistent with the values used in the latest health risk assessment for the OHA facility.

The total lifetime cancer risk in Haverhill from stack emissions from the Ogden Lawrence RDF and North Andover NESWC facilities were calculated by OHA to be less than one in a million for the Lawrence and more than two in

a million for the North Andover facility. The combined total lifetime cancer risk in Haverhill from stack emissions from both facilities was calculated by OHA to be less than three in a million with the location of the maximum exposed individual not stated.

In reviewing the OHA analyses, the Board's consultants disagreed with the results and corrected the risk calculations to account for errors common to the stack health risk assessment from the OHA facility. The Board's consultant estimated a lifetime cancer risk in the Haverhill area of three in a million due to the Lawrence facility and between 11 to 22 in a million for the North Andover facility. The differences between the two health risk estimates made by the Board's and OHA's consultants were due to the following technical issues:

- o Half-life of dioxins/furans in soil
- o Deposition rates of trace metals and organics
- o Bioconcentration factors in fish
- o Mothers' milk contributions for inorganics

If the Board feels that it is important to follow through and complete the health risk assessment for the two existing facilities, the Task Force recommends that OHA conduct an additional stack health risk assessment after the following information has been obtained and technical issues resolved:

- o Stack emissions data based on the compliance tests conducted at the Ogden-Lawrence and North Andover NESWC facilities should be used (unless more recent test data is available).
- o The deposition modeling approach for the Lawrence and North Andover facilities should be consistent with the method used for the OHA stack evaluation.
- o The approach and assumptions for the health risk assessment for the two existing facilities should be consistent with the approach and assumptions used for the OHA stack health risk assessment.

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SYMBOLS AND ABBREVIATIONS

Symbols/Abbreviations

AAL	Allowable Ambient Limits
acfm	Actual cubic feet per minute
BACT	Best Available Control Technology
Board	Haverhill Board of Health
CARB	California Air Resources Board
Cr VI	Hexavalent Chromium
°K	Degrees Kelvin
°F	Degrees Fahrenheit
DDS	Design Data Sheets
DEQE	Department of Environmental Quality Engineering
ESP	Electrostatic precipitators
FF	Fabric Filter
ft.	Feet
fps	Feet per second
gr/dscf @ 12% CO ₂	Grains per dry standard cubic feet corrected to 12% CO ₂
g/sec	grams per second
km	kilometers
lbs/hr	pounds per hour
lbs/MMBtu	pounds per million British Thermal Unit (Btu)
MEI	Maximum Exposed Individual
MSL	Mean Sea Level
m/s	Meters per second

SYMBOLS AND ABBREVIATIONS
(Continued)

ug/m ³	Micrograms (10 ⁻⁶ grams) per cubic meter
mi	Miles
mg	Milligrams (10 ⁻³ grams)
mg/Nm ³ @ 11% O ₂	Milligrams per normal cubic meter corrected to 11% O ₂ (oxygen)
MSW	Municipal Solid Waste
ng	Nanograms (10 ⁻⁹ grams)
Ng/DSCM @ 12% CO ₂	Nanograms per dry standard cubic meter corrected to 12% CO ₂ (carbon dioxide)
OAQPS	Office of Air Quality Planning and Standards
OHA	Ogden Haverhill Associates
PM	Particulate Matter
PMI	Point of Maximum Impact
PCDDs	Polychlorinated dibenzo-p-dioxins (Dioxins)
PCDFs	Polychlorinated dibenzofurans (Furans)
PSD	Prevention of Significant Deterioration
RFA	Refuse Fuels Associates
SCA	Specific Collection Area (sq. ft./1000 acfm)
SDA	Spray Dryer Absorber
sq.ft./1000 acfm	Square Feet per 1000 actual cubic feet per minute
TPD	Tons per Day
TSP	Total Suspended Particulates

SYMBOLS AND ABBREVIATIONS
SUMMARY OF DIOXIN AND FURAN ISOMERS

<u>DIOXINS (PCDD)</u>	<u>ABBREVIATION</u>
1. Total Monochlorinated dibenzo-p-dioxin	Total MCDD
2. Total Dichlorinated dibenzo-p-dioxins	Total DCDD
3. Total Trichlorinated dibenzo-p-dioxins	Total TriCDD
4. 2,3,7,8 Tetrachloro dibenzo-p-dioxin	2378-TCDD
5. Total Tetrachlorinated dibenzo-p-dioxins	Total TCDD
6. Other Tetrachlorinated dibenzo-p-dioxins (Total TCDD - 2378 TCDD)	Other TCDD
7. 1,2,3,7,8 Pentachloro dibenzo-p-dioxin	12378-PCDD
8. Total Pentachlorinated dibenzo-p-dioxins	Total PCDD
9. Other Pentachlorinated dibenzo-p-dioxins (Total PCDD - 12378 PCDD)	Other PCDD
10. 1,2,3,4,7,8 Hexachloro dibenzo-p-dioxin	123478-HxCDD
11. 1,2,3,6,7,8 Hexachloro dibenzo-p-dioxin	123678-HxCDD
12. 1,2,3,7,8,9 Hexachloro dibenzo-p-dioxin	123789-HxCDD
13. Total Hexachlorinated dibenzo-p-dioxins	Total HxCDD
14. Other Hexachlorinated dibenzo-p-dioxins (Total HxCDD - 123478, 123678, & 123789 HxCDDs)	Other HxCDD
15. 1,2,3,4,6,7,8 Heptachlorinated dibenzo-p-dioxin	1234678-HpCDD
16. Total Heptachlorinated dibenzo-p-dioxins	Total HpCDD
17. Other Hepachloarinated dibenzo-p-dioxins (Total HpCDD - 1234678 HpCDD)	Other HpCDD
18. Total Octachlorinated dibenzo-p-dioxins	OCDD
<u>FURANS (PCDF)</u>	
19. Total Monochlorinated dibenzofurans	Total MCDF
20. Total Dichlorinated dibenzofurans	Total DCDF
21. Total Trichlorinated dibenzofurans	Total TriCDD
22. 2,3,7,8 Tetrachloro dibenzofuran	2378-TCDF
23. Total Tetrachlorinated dibenzofurans	Total TCDF
24. Other Tetrachlorinated dibenzofurans (Total TCDF - 2378 TCDF)	Other TCDF
25. 1,2,3,7,8 Pentachloro dibenzofuran	12378-PCDF
26. 2,3,4,7,8 Pentachloro dibenzofuran	23478-PCDF
27. Total Pentachlorinated dibenzofurans	Total PCDF
28. Other Petachlorainated dibenzofurans (Total PCDF - 12378 & 23478 PCDFs)	Other PCDF
29. 1,2,3,4,7,8 Hexachloro dibenzofuran	123478-HxCDF
30. 1,2,3,6,7,8 Hexachloro dibenzofuran	123678-HxCDF
31. 2,3,4,6,7,8 Hexachloro dibenzofuran	234678-HxCDF
32. 1,2,3,7,8,9 Hexachloro dibenzofuran	234678-HxCDF
33. Total Hexachlorinated dibenzofurans	Total HxCDF
34. Other Hexachlorinated dibenzofurans (Total HxCDF - 123478, 123678, 234678, & 123789 HxCDFs)	Other HxCDF
35. 1,2,3,4,6,7,8 Heptachlorinated dibenzofuran	1234678-HpCDF
36. 1,2,3,4,7,8,9 Heptachlorinated dibenzofuran	1234789-HpCDF
37. Total Heptachlorinated dibenzofurans	Total HpCDF
38. Other Heptachlorinated dibenzofurans (Total HpCDF - 1234678 & 1234789 HpCDFs)	Other HpCDF
39. Total Octachlorinated dibenzofurans	OCDF

1.0 INTRODUCTION

1.1 Background Information

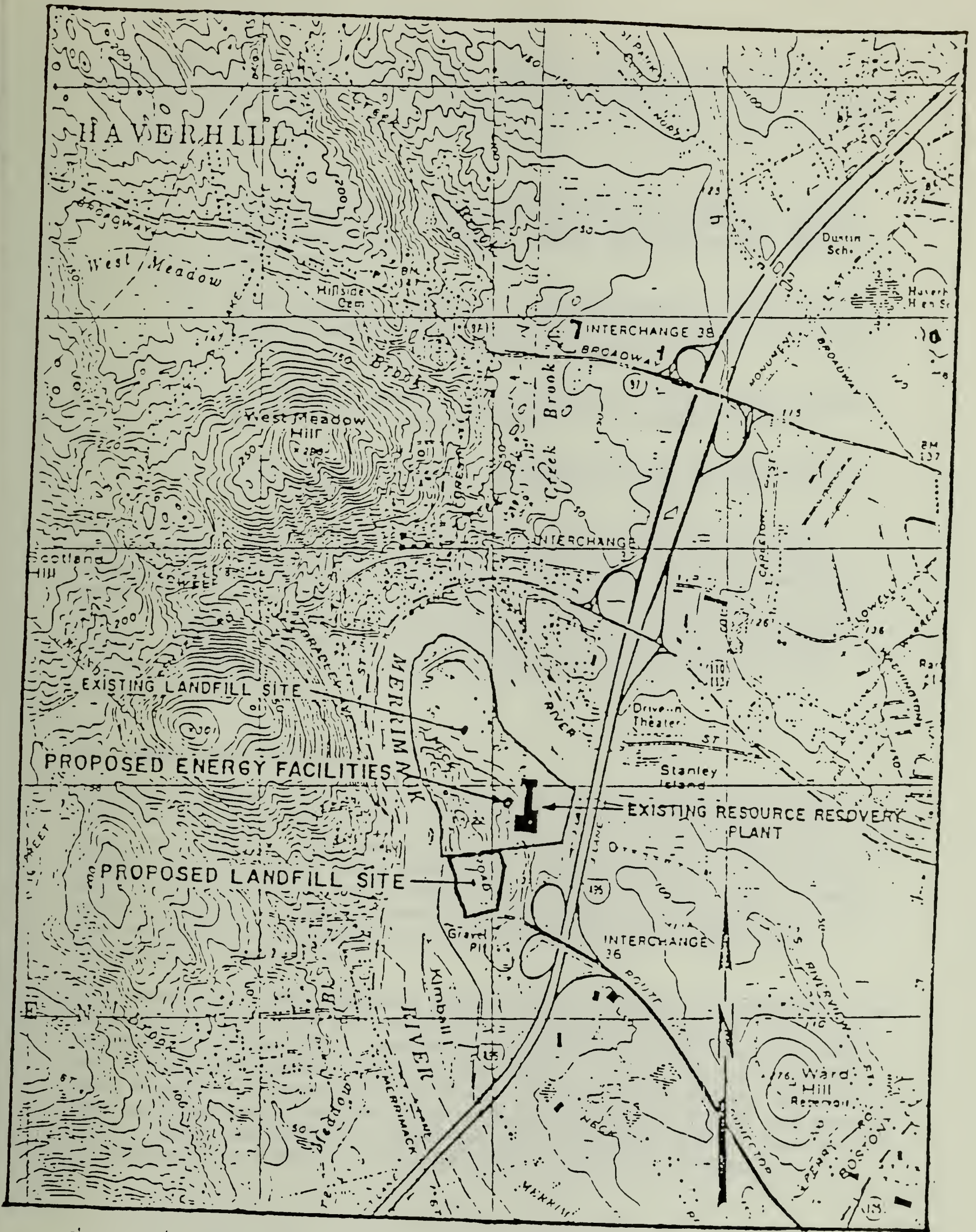
In December 1986, Ogden Haverhill Associates (OHA) acquired the rights to construct a resource recovery facility at the Ward Hill Neck site in Haverhill, Massachusetts (see Figure 1-1). At the time of the closing, all necessary local, state, and federal construction permits had been obtained. An "Air Quality Impact Assessment" report was submitted to the Commonwealth of Massachusetts' Department of Environmental Quality Engineering (DEQE) in June 1986 [1].

In the Summer of 1987, the Haverhill Board of Health (hereinafter "the Board") convened a public hearing under M.G.L. c.111, §150A to consider whether the site assignment previously granted for a solid waste disposal facility on Ward Hill Neck should be modified, suspended, or revoked. The Board retained technical and legal consultants and retained an attorney to moderate the proceedings.

Hearings were conducted under M.G.L. c.30A adjudicatory hearing format. Both oral and written testimony was accepted. OHA's attorneys were given the right of direct cross-examination of the Board's technical consultants, or other expert witnesses sponsored by citizen's organizations. The Board's consultants and OHA were allowed to submit initial and reply briefs.

Hearings were conducted from June 1987 through April 1988. An extensive Hearing Record (hereafter "the Record") consists of the transcripts, prepared testimony, briefs, and other documents which were submitted to the Board.

Based upon what it determined to be its statutory authority, the Board sought this proceeding to determine whether the proposed OHA facility presents a threat to public health, safety, or the environment. In order to determine whether unacceptable risks are likely to occur to the public or the environment due to operation of the proposed facility, the Board requested that OHA prepare a health risk assessment of the stack emissions and ash handling operations of the proposed facility. These requests took the form of detailed instructions in a format called "Information Requests" ("IR") as prepared by the Board's consultants based on risk assessment protocols developed for other resource recovery facilities. These "protocols" were not mutually agreed upon procedures, but rather in the form of "interrogatories" requiring a response from OHA. The information requests and responses included in the Record that are relevant to the air quality and risk assessment analyses are IR Sets II, IIIA, V, and VI.



0' 1000' 2000' 3000' 4000'

SCALE

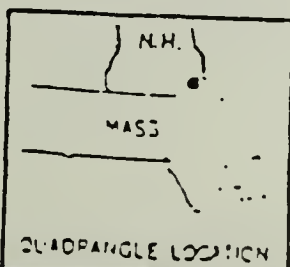


Figure 1-1

Location of OHA Site

Consistent with standard practice, a health risk assessment process generally involves four steps [12], each of which require the assimilation of large amounts of data. The preparation of the health risk assessment for the OHA facility included the completion of the following four analyses:

1. Hazard Identification - Determination of whether a particular pollutant is released from the OHA facility and the potential adverse healths effects associated with these pollutants.
2. Dose-Response Assessment - Determination of the relation between magnitude of exposure and the probability of occurrence of the health effects in question.
3. Exposure Assessment - Determination of the extent of human exposure after the application of regulatory controls.
4. Risk Characterization - Determination of the magnitude of human health risks due to exposure to pollutants.

The health risk assessment process requires many assumptions and a substantial amount of scientific data. Where reliable site-specific information was available, it was used in the risk assessment analysis. Where reliable data were not avialable, the Board requested that upper level estimates be used in order to guard against underestimation of risk. Based on the review of the Record, the major areas of disagreement between the Board and OHA involve the degree of conservatism of the selected assumptions.

1.2 Task Force Agreement

At the conclusion of the public hearing process, the Board had still not resolved five technical issues with respect to the environmental impact of the OHA facility. After extensive negotiations on December 13, 1988, the Board, OHA, and Refuse Fuels Associates (RFA) entered into an Agreement with the Department of Environmental Quality Engineering (DEQE) to refer certain specific issues of concern to DEQE and its research facility at the University of Massachusetts at Amherst for further review and investigation (Appendix A).

The December 13, 1988 Agreement established a procedural protocol for the collection, evaluation and reporting of technical information under the supervision of the DEQE to assist the Board in answering the five technical issues with respect to the hearing record. Based on this Ageement, DEQE supervised the technical review to address the questions specified in the Agreement utilizing qualified technical personnel of DEQE and through its existing contractual arrangements with The Environmental Institute of the University of Massachusetts (UMass) at Amherst, Massachusetts.

A Task Force Team was created that included the following:

- (a) Investigative Team consisting of Dr. Salvatore R. DiNardi (UMass, Principal Investigator), Dr. Richard R. Knapp (Summit Environmental Engineering), and Mr. Charles E. Kitson (C.E. Kitson & Associates).
- (b) DEQE Technical Staff consisting of Dr. Andrea Papadopoulos (Office of Research and Standards, Task Order Manager), Mr. Robert T. Donaldson, (Division of Air Quality Control), Ms. Carol Rowan West (Director, Office of Research and Standards), Mr. Steven Dennis (Division of Air Quality Control), and Mr. Edward McDonald (Northeast Regional Office).

As specified in the December 13, 1988 Agreement, all final written reports are to be made available to the Board, OHA, and RFA for use in connection with the Board's site assignment review. This report has been reviewed by a peer review group consisting of technical experts from within and outside DEQE.

Following completion of the study, the Board may commence a new hearing, if deemed necessary, pursuant to M.G.L. c.111, §150A to evaluate the conclusions of the review and investitation to determine whether the operation of the mass burn solid waste disposal, resource recovery and electric generating facility results in a threat to the public health and safety or the environment.

2.0 TECHNICAL ISSUES

2.1 Scope of Work

Based on the December 13, 1988 Agreement, the Task Force's scope of work was divided into five technical issues or tasks. The first four tasks were established to answer specific technical questions that have arisen during the course of the hearing held by the Board in connection with the review of the site assignment for the Ward Hill Neck Facility. The fifth task was established to define the need and develop the scope for an on-site and ambient air quality monitoring program as discussed in the Agreement.

This report addresses the first four tasks as authorized under the Task Order Agreement. The Task Force is presently working on finalizing the scope of the ambient monitoring program (Task 5) to be carried out by OHA. It is expected that this task will be completed by July 1, 1989. The scope of work for the first four technical tasks are as follows:

TASK 1: Review and Evaluate Stack Emissions Data Used for the Air Quality and Health Risk Assessment for the Ogden Haverhill Facility.

Objective 1. Review and Compare Stack Emissions Data

Review the stack emissions data used in the OHA's ambient air quality and health risk assessment and compare with the stack emissions data reported from other resource recovery plants with similar technology. Sources of stack emissions data included (1) the Joy/Niro Report and supporting materials on recently concluded dioxin air emission testing of the Zurich Josefstrasse facility in Zurich, Switzerland; (2) recent dioxin air emission data from the Millbury, Massachusetts mass-burn facility; and (3) other relevant air emission data for similar facilities.

Objective 2. Extrapolate Modeling Results with New Stack Emissions Data

Based on the reported stack emission data found for the other similar facilities, extrapolate (to the extent possible) the air quality modeling results presented in the OHA's ambient air quality and health risk assessment.

TASK 2: Review and Evaluate Ash Emissions Data and Air Quality Modeling Methodology used for the Haverhill Landfill.

Objective 2. Review and Compare Ash Emissions Data

Evaluate the appropriateness of the ash emissions data used in the OHA's screening level and refined health risk assessment and compare with reported fugitive emission data available from existing landfill areas. Determine the applicability of these data for use in a health risk assessment and adjust the data (as necessary) to reflect OHA's proposed ash management techniques.

Objective 2. Evaluate Fugitive Ash Modeling Approach

Evaluate the air quality modeling assumptions and methodology used in the air quality assessment of the fugitive ash emissions from the Haverhill Landfill. Evaluate the sensitivity of the modeling assumptions on the model predictions.

Objective 3. Determine the Need for an On-site Monitoring Program

In the event that it is determined that a short-term fugitive ash emissions monitoring program could yield scientifically reliable and usable data for the risk assessment, design a short-term air quality monitoring program for fugitive ash emissions at an existing site similar to the Haverhill Landfill to collect pollutant-specific concentrations and particle size distribution data.

TASK 3: Evaluate Appropriateness of Logan Airport Meteorological Data.

Objective 1. Review Logan Airport Meteorological Data

Review the technical basis for the use of five years of Logan Airport meteorological data in the air quality modeling analysis conducted for the OHA facility. In determining the appropriateness of meteorological data used in the air quality analysis, the Task Force shall compare the Logan Airport data with local meteorological data (if available). Evaluate the probable effects on predicted pollutant concentrations resulting from differences between Logan and local meteorological data.

Objective 2. Design an On-site Meteorological Monitoring Program

If insufficient local data are available, design a short-term meteorological monitoring program to measure local conditions for the purpose of evaluation of the appropriateness of Logan Airport data.

TASK 4: Review and Evaluate the Interactive Modeling of the Existing Sources in Haverhill Area.

Objective 1. Review the Previously Conducted Interactive Modeling Study

Evaluate the appropriateness of the emissions data and modeling procedures used by OHA for the air quality modeling of emissions from existing municipal solid waste (MSW) combustion facilities - Lawrence RDF facility and the North Andover NESWC facility. Using the most current stack emissions data obtained from compliance testing, compare the emissions data with the stack emissions data used in the OHA modeling assessment.

Objective 2. Perform Interactive Modeling of Existing Sources

If warranted, prepare a modeling protocol defining the modeling approach and stack parameters to be used in the background modeling analysis. OHA is responsible for conducting the air quality modeling assessment.

Objective 3. Review Interactive Modeling Assessment (If Conducted)

Review the interactive modeling conducted by OHA and summarize the results to estimate the background air quality concentrations due to emissions from existing solid waste combustion facilities in the Haverhill area.

2.2 Technical Approach and Methodology

In addressing the technical questions, the Task Force used technical data included in the Hearing Record and obtained additional information from the technical consultants used by the Board and OHA. In addition, the Task Force used relevant technical data as made available to DEQE from its existing database or otherwise obtainable from other sources as necessary to provide scientifically valid answers to the questions. The approach and methodology used to answer the specific questions included in each task are as follows:

TASK 1: Review and Evaluate Stack Emissions Data Used for the Air Quality and Health Risk Assessment for the Ogden Haverhill Facility.

The Task Force reviewed and compared stack emissions data from the following sources:

- o Stack emissions data used in the initial air quality permit application for the OHA facility in 1986 [1].
- o Stack sampling results and facility description for the Zurich Josefstrasse facility in Zurich, Switzerland [2].
- o Stack emissions data as developed in response to IR Set V and used in the initial health risk assessment [2, 3].
- o Stationary source sampling results from the Wheelabrator Millbury (Massachusetts) Resource Recovery Facility [4, 5, 6]
- o Stationary source sampling results from the Ogden-Lawrence RDF and the North Andover NESWC facilities [39, 40].

In order to properly compare the stack emissions data used in the OHA's ambient air quality and health risk assessments with stack emissions data from other resource recovery plants, the stack emissions data from the above sources had to be compared on a standard basis. The pollutant

emissions data from stack sampling tests are reported in different units. For example, the particulate and trace metal emissions from the Millbury Resource Recovery Facility were reported [4, 5] in the following units: gr/dscf corrected to 12% CO₂, micrograms per grams of particulate, lbs/hour, and lbs/MMBtu.

Air quality dispersion models were used to estimate ambient air quality concentrations and deposition rates due to pollutant emissions from the OHA facility. The air quality modeling results were used in the risk assessment to determine the impact of each pollutant on human receptors. Stack pollutant emission rates are one of many required input parameters to air quality dispersion models and are normally input in grams per second (g/sec). Because the air quality modeling results are used directly in the risk assessment analysis, it was decided that stack emissions data would be presented in the units of grams per second.

TASK 2: Review and Evaluate Ash Emissions Data and Air Quality Modeling Methodology used for the Haverhill Landfill.

At the start of the Task Force study, it was determined that a short-term on-site monitoring program to measure the fugitive ash emissions at the OHA Landfill or an existing site similar to the Haverhill facility could not be designed, conducted, and analyzed during the course of this review. Therefore, the Task Force did not request that OHA conduct a short-term air quality monitoring program to measure pollutant-specific concentrations and particle size distribution data.

To evaluate the appropriateness of the ash emissions rates used in the OHA's health risk assessment, the Task Force evaluated the U.S. EPA emission factor equations used in the analysis and reviewed reported fugitive emission data from existing landfill areas. Ash data was provided by OHA from a soil sampling program conducted at the Marion County Resource Recovery Facility and the accompanying Woodburn Ash Monofill in Oregon [29]. In addition, ambient air monitoring data collected at the ash disposal site at the RESCO Saugus (MA) facility were reviewed to determine if pollution emission rates could be determined from the four sampling sites on the RESCO ash landfill and one background site, which were located on and around the RESCO facility [18].

With the lack of any acceptable empirical data on ash emissions from the disposal and landfiling operations, the fugitive ash emissions due to the ash handling activities at the OHA facility were estimated based on empirical equations developed for the U.S. EPA [19]. Over the 1987 and 1988 period, OHA submitted screening and refined ash health risk assessments based on different assumptions for the ash handling operations at the OHA facility. The Task Force reviewed the empirical equations and assumptions used by OHA to estimate the pollutant emissions from the ash handling activities.

The Task Force also evaluated the air quality modeling methodology and assumptions used in the air quality assessment of the fugitive ash emissions from the Haverhill Landfill. In order to evaluate the differences between the health risk conclusions presented by OHA and the Board's consultants, the Task Force met with both technical consulting groups. In addition, the Task Force requested that OHA conduct additional air quality modeling analyses incorporating the conditions imposed by the ash management techniques proposed by OHA and expanding the analyses to two hypothetical locations of the monofill source at the Haverhill Landfill.

TASK 3: Evaluate Appropriateness of Logan Airport Meteorological Data.

Data from an existing on-site meteorological monitoring program, which was reported to be a portable meteorological installation located on the roof of the existing boiler structure, was judged by the Task Force to be unacceptable for the purposes of this study due primarily to the likelihood that aerodynamic wake effects from plant structures have influenced the data.

It was further determined that a short-term on-site monitoring program (during the course of this study) would not provide meaningful information on the differences between on-site conditions and those existing at Logan Airport. The rationale is that an outstanding concern of the Haverhill Board of Health has been the long-term (i.e., annual average) air quality impacts from the OHA facility, and the associated implications regarding the health risk assessment. A short-term monitoring program of one or two months in duration would not provide a sound basis for assessing the long-term differences between on-site conditions and conditions at Logan Airport.

An evaluation has been made as to the appropriateness of using five years of Logan Airport data in the air quality modeling analysis. The 1983 Logan Airport data was compared with available local meteorological data. The observed meteorological data were first compared on an hour-by-hour basis from the records of Logan Airport and the Lawrence Municipal Airport. Lawrence reported 4,001 data hours in 1983, out of a possible 8,760 hours. Only concurrent hours recorded at Logan Airport were used in order to provide a meaningful comparison.

The study proceeded in accordance with the following broad concepts:

1. Evaluate the similarities and differences between the two meteorological data bases.
2. Assess the likely effects on predicted (modeled) air pollution concentrations from the OHA facility resulting from any differences in meteorological conditions. This to be done for:
 - (a) Fugitive ash emissions from the monofill.
 - (b) Stack emissions.

3. Draw conclusions on the appropriateness of predicting pollutant concentrations from the OHA facility using five years of Logan Airport data.

Computer modeling of air pollutant emissions is a predictive tool used to estimate ambient pollutant concentrations. This modeling is essentially a mathematical simulation of the emissions characteristics (e.g., emission rate, height of release, temperature of buoyant releases, etc.) and the atmospheric processes which transport and disperse the pollutants. Wind direction is the important parameter in pollutant transport, while atmospheric stability in concert with wind speed plays a key role in dispersion.

Atmospheric stability is a term related to the turbulent state of the atmosphere, which in turn governs the rate of vertical and horizontal spread of a released pollutant plume. Although atmospheric stability will range over a continuum from extremely unstable to extremely stable, this has been difficult to measure and represent in air quality modeling. As an alternative, stability is characterized as falling into six categories, called Pasquill-Gifford classes "A" through "F". The rates of plume spreading for each of these classes have been approximated through field experiments. Class "A" is extremely unstable (with rapid plume spreading) and class "F" is extremely stable (with minimal spreading).

Where direct measurements of atmospheric turbulence are unavailable, the Pasquill-Gifford stability class can be estimated on an hourly basis using an empirical relationship which takes into account the date and time of day, and observations of wind speed, cloud cover, and ceiling height. These observations are routinely taken at major airports, and it was in this manner that stability class was calculated for the modeling done for the OHA facility.

Since the Logan Airport data base alone contained sufficient information to derive stability class, it was not possible to compare stability data between Logan and Lawrence Airports.

The data bases were compared in terms of frequency of occurrence of wind direction and speed. Average wind speeds were calculated for each data base as a whole, and also as a function of wind direction as well as a function of Pasquill-Gifford stability class (derived from Logan Airport data).

Pursuant to a request by the Task Force, OHA's consultant (Sigma Research Corporation) conducted a modeling study [37] of the ash emissions sources at the monofill. The purpose of this study was to rank hourly contributions to the overall annual average value by time of day, stability class, and wind speed. The results of this modeling were used to assist in judging the effects on predicted concentrations resulting from differences in meteorological conditions. No modeling of this type was conducted for stack emissions.

TASK 4: Review and Evaluate Stack Emissions Data Used for the Air Quality and Health Risk Assessment for the Ogden Haverhill Facility.

The Task Force reviewed the interactive modeling analysis prepared by OHA for the two other resource recovery facilities identified in the Haverhill region. In conducting the above analysis, the Task Force reviewed the following documents:

- o Interactive modeling conducted for sulfur dioxide and total suspended particulates (TSP) in the air quality permit application for the OHA facility in 1986 [1].
- o Health risk assessments as conducted by OHA for the Lawrence RDF and the North Andover NESWC facilities as submitted in response to Information Request Set V (Question 29).
- o Current stack emissions data obtained from compliance testing reports for the Lawrence RDF and North Andover NESWC facilities [39, 40].

In the health risk assessment conducted for the two existing facilities, air quality dispersion models were used to estimate ambient air quality concentrations and deposition rates due to pollutant emissions from each facility. The air quality modeling results were used in the separate risk assessment conducted for each facility to determine the impact of each pollutant on human receptors.

In order to evaluate the appropriateness of the emissions data and modeling procedures used by OHA for the two existing MWS combustion facilities in the Haverhill area, pollutant emissions rates and stack parameters used in the modeling analysis were reviewed and compared with facility information obtained from the Massachusetts DEQE.

3.0 REVIEW AND EVALUATION OF TECHNICAL ISSUES

3.1 TASK 1: Review and Evaluation of Stack Emissions Data

3.1.1 Facility Comparison

A technical review and comparison was made of design information for the Ogden Haverhill, Zurich Josefstrasse, and the Wheelabrator Millbury resource recovery facilities. The information consisted of completed DEQE Design Data Sheets (DDS) that were submitted to the DEQE as part of the permit application for the Haverhill and Millbury facilities, and as requested from OHA by the Task Force for the Zurich facility. In addition, OHA submitted other technical information describing the operation of the Zurich facility.

Design Data Sheets (DDS) for the incinerator furnaces, spray dryers, and electrostatic precipitators (ESPs) together with actual stack emission test data from Millbury and Zurich were reviewed and compared to stack emissions data used in the air quality and health risk assessment analyses for the OHA facility. In addition, DEQE files were reviewed to obtain similar information for the Lawrence RDF facility and the North Andover NESWC facility.

Table 3-1 compares the physical and performance characteristics of the resource recovery facilities in Haverhill (MA), Millbury (MA), Lawrence (MA), North Andover (MA), and Zurich (Switzerland).

In 1987, OHA stated that no Ogden facility is operating with a dry scrubber/four-field ESP that is comparable with the air pollution control technology proposed for the Haverhill facility. As a result, OHA assembled data from an older facility in Zurich, Switzerland that has been recently retrofitted with a dry scrubber. The Zurich Josefstrasse facility has a retrofitted rotary atomizer spray dryer absorber (SDA) and a two-field ESP control system on its Martin GmbH mass-burn stoker boiler. Based on OHA's contention that the existing Zurich facility is similar to the proposed OHA facility, stack test emissions data from the Zurich facility were used to estimate the pollutant emissions from the OHA facility.

As indicated by the information provided in Table 3-1 (Columns B and C) for the technical issues relevant to this task, the Wheelabrator Millbury and the Zurich Josefstrasse facility are similar in design and have similar air pollution control equipment. The design capacity of the Zurich facility is reported to be 500 tons per day (TPD) while the capacity of one unit at the OHA facility is 825 TPD. Particulate emissions from the Zurich facility are controlled using a two-field ESP with a permit limit of 50 mg/Nm³ corrected to 11% oxygen.

The OHA facility with a dry scrubber/four-field ESP system presently has a maximum particulate emission rate limit of 0.015 gr/dscf corrected to 12% CO₂. The maximum particulate emission limit for the OHA facility is

TABLE 3-1

COMPARISON OF CHARACTERISTICS OF RESOURCE RECOVERY
FACILITIES USED IN THE HEALTH RISK ASSESSMENT

COLUMNS	[A]	[B]	[C]
<u>Location</u>	Haverhill, MA	Millbury, MA	Zurich, Switzerland
Start-Up Date	April 1989	September 1987	Retrofitted 1986
<u>Furnace</u>			
Fuel	MSW	MSW	MSW
Vendor	Martin	Von Roll	Martin
Capacity (TPD)	2 x 825 TPD	2 x 750 TPD	1 x 500 TPD
<u>Spray Dryer (per Unit)</u>			
Vendor	Niro	Wheelabrator	Niro
Inlet Flow (ACFM)	202,610	174,500	142,000
Inlet Temperature (°F)	430	415	480
Outlet Flow (ACFM)	182,010	162,000	115,300
Outlet Temperature (°F)	285	236	240
<u>Electrostatic Precipitator (per Unit)</u>			
Vendor	Combustion Engineering (Rotary Atomizer)	Wheelabrator (Atomizing Nozzles)	Elex (Rotary Atomizer)
Fields	4	3	2
SCA - Specific (*) Collection Area (sq.ft./1000 acfm)	476	360	383
<u>Emissions</u>			
Particulate Matter Permit Limit (gr/DSCF @ 12% CO ₂)	0.015	0.030	0.020

(*) Based on information provided in ESP Design Data Sheets (DDS-3f).

TABLE 3-1 (Continued)

COMPARISON OF CHARACTERISTICS OF RESOURCE RECOVERY
FACILITIES USED IN THE HEALTH RISK ASSESSMENT

COLUMNS	[A]	[D]	[E]
<u>Location</u>	Haverhill, MA	North Andover, MA	Lawrence, MA
Start-Up Date	April 1989	May 1984	June 1982
<u>Furnace</u>			
Fuel	MSW	MSW	RDF
Vendor	Martin	Martin	B & W w/ Detroit Stoker Feeder
Capacity (TPD)	2 x 825 TPD	2 x 800 TPD	1 x 576 TPD
<u>Spray Dryer (per Unit)</u>			
Vendor	Niro	N/A	N/A
Inlet Flow (ACFM)	202,610	-	-
Inlet Temperature (°F)	430	-	-
Outlet Flow (ACFM)	182,010	-	-
Outlet Temperature (°F)	285	-	-
<u>Electrostatic Precipitator (per Unit)</u>			
Vendor	Combustion Engineering (Rotary Atomizer)	Wheelabrator	Elex (Rotary Atomizer)
Fields	4	3	2
SCA - Specific (*) Collection Area (sq.ft./1000 acfm)	476	340	> 548(**)
<u>Emissions</u>			
Particulate Matter Permit Limit (gr/DSCF @ 12% CO ₂)	0.015	0.050	0.025(***)

(*) Based on information provided in ESP Design Data Sheets (DDS-3f).

(**) This SCA is for the facility as designed. Because DEQE has imposed an operating restriction on the facility the flue gas flow is lower, therefore, increasing the SCA.

(***) Particulate emission permit limit based on Lowest Achievable Emission Rate (LAER) determination.

approximately equal to a permit limit of 25 mg/Nm³ corrected to 11% oxygen, which is one-half the permit limit of the existing Zurich facility. With the four-field ESP system installed at the OHA facility, it is expected that the Haverhill facility should have no problems meeting their existing permit limit.

The Wheelabrator Millbury, Inc. (WMI) Resource Recovery Facility in Millbury, Massachusetts was designed, constructed, and operated by Wheelabrator Environmental Systems, Inc. The Millbury facility is a mass burn municipal waste combustion facility consisting of two identical combustor, boiler, and flue gas treatment systems that exhaust into one common stack.

The Millbury facility became operational in September 1987 and completed its compliance testing in February 1988. The Millbury facility is designed to burn 1500 tons per day (TPD) of trash in two incinerators. The trash includes all household garbage, trash, rubbish, and yard waste with a small percentage made up of commercial and light industrial waste.

Each of the two identical 750 TPD units consist of a Babcock and Wilcox waterwall furnace and boiler that is equipped with a Von Roll reciprocating stoker grates and hydraulic ram waste feed system with primary combustion air intakes located above the enclosed tipping floor. Each incinerator is equipped with a separate emission control system consisting of a spray dryer absorber (SDA) for acid gas removal and a three-field electrostatic precipitator (ESP) for control of suspended particulate emissions.

Each of the SDA systems is 25 feet in diameter and 70 feet tall. The hot flue gases enter the top of each dryer where the flue gas is evenly distributed within the vessel using a roof gas disperser. Atomized lime slurry is sprayed into the flue gas where it evaporates and simultaneously reacts with the sulfur dioxide (SO₂) and acid gases in the flue gas. The lime slurry is atomized using multiple two-fluid nozzles where compressed air (the second fluid) is used to produce small droplets. The dried reaction products and fly ash are ducted to the ESP system.

Each electrostatic precipitator consists of a three-field rigid discharge electrode unit designed by Wheelabrator Air Pollution Control Systems. Collected particulates are dislodged from the discharge electrodes using gravity impact rappers with each of the three plates rapped sequentially.

Comparisons of the information provided in Table 3-1 (Columns A and B) indicate that the Haverhill and Millbury facilities are very comparable in design and size. Each facility has state-of-the-art combustion and air pollution control systems. The maximum allowable emission rate for particulate matter is 0.030 gr/DSCF corrected to 12% CO₂ for the Millbury facility (which became operational in September 1987) and 0.015 gr/DSCF corrected to 12% CO₂ for the OHA facility (final operating permit received in April 1989).

As shown in information provided in Table 3-1 (Columns D and E), the North Andover NESWC and the Lawrence RDF facilities have a three-field and a two-field electrostatic precipitators, respectively, but do not have a

spray dryer system to control acid gas emissions. The maximum allowable emission rate for particulate matter is 0.050 gr/dscf corrected to 12% CO₂ for the NESWC facility which became operational in 1984. The particulate emission rate for the Lawrence RDF facility, which became operational in 1982, is 0.025 gr/dscf corrected to 12% CO₂ and was based on the Lowest Achievable Emission Rate (LAER) evaluation.

3.1.2 Ogden Haverhill Air Permit Application

Ogden Haverhill Associates (OHA) submitted an "Air Quality Impact Assessment" report in June 1986 [1] for its proposed 1650 tons per day (TPD) solid waste to energy facility in Haverhill, Massachusetts. The resource recovery facility will consist of a Martin mass-burn unit with a peak steam capacity of 395,000 pounds per hour. The Martin unit is designed to burn municipal solid waste (MSW). Emissions from the proposed Haverhill facility will be controlled by use of a dry flue gas cleaning system using a lime-slurry-based dry scrubber for acid gas control and a high efficiency electrostatic precipitator (ESP) for particulate control.

The OHA facility is located in a nonattainment area for total suspended particulates (TSP) and ozone. As required by the Clean Air Act Amendments of 1977, the nonattainment designation includes areas not meeting National Ambient Air Quality Standards (NAAQS). Most designations were based upon air quality monitoring data; some were based upon air quality dispersion modeling. All new sources locating within a nonattainment area and having potential emissions of the nonattainment pollutant exceeding 100 tons per year are subject to nonattainment review.

For the proposed Haverhill Resource Recovery Facility, OHA proposed that particulate matter will be controlled to 0.015 grains per dry standard cubic feet (gr/dscf) corrected to 12% CO₂. The annual emissions of particulate matter from the OHA facility was projected to be 94.2 tons per year. With the annual emissions of particulate matter projected to be less than 100 tons per year, the proposed OHA facility was not subject to the nonattainment requirements of Lowest Achievable Emission Rate (LAER) and emission offsets.

In its December 17, 1986 Conditional Approval, DEQE stated that the proposed use of a dry scrubber and a four-field ESP with a maximum particle emission rate of 0.015 gr/dscf corrected to 12% CO₂ was considered "best available control technology."

The proposed control of particulate matter emissions to 0.015 gr/dscf corrected to 12% CO₂ was based on stack testing results of the Munich North Test Program performed on a Martin facility [8] with similar air pollution control equipment. The air pollution control system for the Munich North facility consists of a dry scrubber reactor followed by a two-field electrostatic precipitator. Block 3 of the Munich North Refuse-Fired Power Plant consists of two incinerator boiler units, each designed to burn 22 tons per hour (528 TPD) of municipal solid waste and 12 tons per hour of clarifier sludge from the adjacent sewage treatment plant. During the

emissions testing period, no sewage sludge was fired. Each boiler is designed to produce 110,000 pounds per hour of steam. Each incinerator boiler consists of a mass-fired reciprocating grate with a water-wall boiler.

Based on the Munich North data, OHA assumed a uncontrolled particulate loading of 3.0 gr/dscf (2.5 gr/dscf after the economizer plus 0.5 gr/dscf of reagent from the scrubber) for the OHA facility. Assuming an ESP control efficiency of 99.5 percent, OHA proposed a particulate emission limit for the OHA facility of 0.015 gr/dscf corrected to 12% CO₂ [3.0 gr/dscf x (1.0 - 99.5/100.0)] and calculated the particulate emission rate for both units as follows:

$$\begin{aligned}
 & 0.015 \frac{\text{gr}}{\text{dscf}} \times \frac{1.0 \text{ lb}}{7000 \text{ gr}} \times 60 \frac{\text{min}}{\text{hr}} \times 83,471 \frac{\text{dscf}}{\text{min, Unit}} \times 2 \text{ Units} = \\
 & \quad - 21.5 \frac{\text{lbs}}{\text{hr}} \text{ PM} = 2.71 \text{ grams/sec PM}
 \end{aligned}$$

Maximum short-term and annual average pollutant emissions from the OHA facility were estimated assuming full-load operation of 395,000 pounds per hour of steam generation. Table 3-2 (Column B) summarizes the stack emission rates that were used in OHA's "Air Quality Impact Assessment" analysis. Only the pollutants that have been found to be important in the health risk assessment (as required by the Board) have been listed in Table 3-2.

Trace Metals

The emission factors used for trace metals for the OHA facility were based on stack testing results from similar waste to energy facilities (Appendix A of OHA's "Air Quality Impact Assessment"). Table 3-2 (Column A) presents the trace metal weight percentages of the total particulate emissions used in the 1986 air quality assessment to calculate the emission rates of metal pollutants from the proposed OHA facility. The weight percentages were based on work done for the Irwindale Resource Recovery Facility's Risk Assessment [9] and were reported by OHA to be maximums. The emission rate for trace metals for the OHA facility were found by the following equation:

$$\begin{aligned}
 & \begin{array}{l} \text{Trace Metal} \\ \text{Emission Rate} - \end{array} \begin{array}{l} \text{Trace Metal} \\ \text{Weight Percentage (\%)} \end{array} \begin{array}{l} \text{of} \\ \text{of Particulate Emissions} \end{array} \times \begin{array}{l} \text{Total Particulate Matter} \\ \text{Permit Limit Emission} \\ \text{Rate (g/sec)} \end{array} \\
 & \quad - \frac{\text{Weight \% (Table 3-2, Col. A)}}{100} \times 2.71 \text{ g/sec}
 \end{aligned}$$

Table 3-2 (Column C) lists the reference source for the trace metal weight percentages used in the air quality assessment. For example, the weight percentage of particulate emissions for arsenic is based on the maximum measured weight percentage at seven German plants.

TABLE 3-2

SUMMARY OF STACK EMISSION RATES
USED IN PERMIT APPLICATION ANALYSIS
FOR PROPOSED OGDEN HAVERHILL FACILITY
(June 1986)

COLUMNS	[A]	[B]	[C]
<u>Pollutant</u>	<u>Weight Percentage of Particulate Emissions (%)</u>	<u>Emission Rate (g/sec)</u>	<u>Emission Rate Reference</u>
Total Particulate Matter (PM)	1.00E+02	2.71E+00	Permit Limit (DEQE)
Arsenic (As)	5.30E-02	1.44E-03	Kirsch (Max. of 7 German Plants)
Cadmium (Cd)	1.67E-01	4.60E-03	Westchester RESCO (Single Stack Test)
Nickel (Ni)	1.49E+00	3.99E-02	Sheridan Avenue (Average - 6 Tests)
Lead (Pb)	6.19E+00	1.68E-01	Kirsch (Max. of 7 German Plants)
Chromium (Cr)	4.30E+00	1.17E-01	Munich North (Maximum)
Dioxins (PCDD)	-	9.74E-06	Average Emissions (4 similar Ogden Martin Facilities)
Furans (PCDF)	-	18.52E-06	Average Emissions (4 similar Ogden Martin Facilities)
Total PCDD+PCDF	-	28.26E-06	Average Emissions (4 similar Ogden Martin Facilities)

Note:

Exponential format used - e.g., 5.30E-02 is equal to 5.3×10^{-2} is equal to 0.053; 4.30E+00 is equal to 4.30.

A necessary element of any permit application to the DEQE is a demonstration of compliance with the state's Allowable Ambient Limits (AALs). Using the emission rates based on the metal weight percentages, the air quality assessment submitted by OHA stated that the maximum 24-hour average concentrations for all metals would be below the appropriate AALs with the exception of nickel, which was equal to the 24-hour average AAL.

The Board's consultants, in reviewing the air permit materials submitted by OHA, noted that OHA did not use the maximum weight percentages for cadmium, nickel, and lead. The Board's consultants stated that when the maximum weight percentages were used, the trace metal emissions from the OHA facility would result in exceedances of the AAL's for cadmium, nickel, and lead. Appendix A to the "Air Quality Impact Assessment" [1] contains information that supports the fact that OHA did not use the maximum emission rates for certain air toxic pollutants.

In response to the statement that use of the maximum weight percentages would result in exceedances of the health-based AALs for some trace metals, the DEQE reviewed the information included in the Hearing Record. In 1986, the DEQE compared the estimated ambient impact due to emissions from the proposed OHA facility with the then-existing AALs and determined that the facility could meet all applicable AALs. At that time, the AALs were draft, internal working guidelines used by DEQE as policy not as regulations.

In October 1988, the DEQE stated [43] that "upon a review of more recent emissions data from comparable facilities, it is the Department's opinion that the OHA facility should be able to demonstrate compliance with AALs and therefore operate in a mode that is protective of public health. Of the 15 to 20 compounds reviewed only mercury surfaced as a pollutant of potential concern. The database shows a wide range of emission levels and as a result the Department will review testing results from the OHA facility very closely. In general, if the OHA facility does not demonstrate compliance with AALs, the Department will initiate actions through either a revised permit or enforcement measures to implement corrective actions."

During the first year of operation, the OHA facility will undergo two comprehensive stack testing programs: (1) startup/compliance testing; and (2) routine compliance testing (nine months later) as required by the Solid Waste Bill (Chapter 584 of the Acts of 1987). Based on the results of this stack emissions data, the DEQE has the authority under its air pollution control regulations, 310 CMR §7.00, et. seq., to modify the final operating permit if testing results suggest permit modifications are warranted [43].

Dioxins/Furans

When the air quality assessment study for the OHA facility was conducted in 1986 [1], the DEQE ambient air guideline for total polychlorinated dibenzo-p-dioxins (PCDD) and total polychlorinated dibenzofurans (PCDF) in Massachusetts was 2.2 picograms per cubic meter (gaseous) and 1.1 picograms per cubic meter (particulate) based on an annual averaging period.

The DEQE has recently changed the terms of its Dioxin Guideline to a 2,3,7,8-TCDD toxic equivalent basis. The guideline as modified represents the same level of health protection. The emission testing programs described above will generate data which will be used to determine compliance with the DEQE's Dioxin Guideline.

As shown in Table 3-2 (Column B), the average emission rates of PCDDs and PCDFs are based on the stack testing results at four similar Ogden Martin facilities. As presented in Appendix B of OHA's "Air Quality Impact Assessment" report, the maximum emission rate of PCDD shows a maximum value of 0.72 mg/ton for the Martin Unit MVA I Borsigstrasse (W. Germany).

For the OHA facility with a waste input rate of 1650 tons per day, the maximum PCDD emission rate is over 40% higher than the average emission rate used in the air quality analysis. The maximum emission rate of PCDF shows a maximum value of 1.55 mg/ton for the Martin Unit MVA II Stelling Moore (W. Germany). For the OHA facility with a waste input rate of 1650 tons per day, the maximum PCDF emission rate is over 50% higher than the average emission rate used in the OHA analysis.

The emission rates for PCDD and PCDF used in the air quality assessment were based on average values from four facilities and not the maximum reported values. In their response to IR Set V, OHA presented more recent stack test data for PCDD and PCDF from a facility similar in design to the OHA facility. Based on these emission rates and the air quality modeling results presented in OHA's "Air Quality Impact Assessment" report, the annual impact due to dioxin and furan emissions from the OHA facility showed compliance with the DEQE ambient guidelines. According to DEQE, it is appropriate to use average emissions values (from stack test results) when comparing calculated ambient concentrations to annual average air quality standards, guidelines, or risk assessments.

3.1.3 Ogden Haverhill Stack Risk Assessment

The Board requested in IR Set V (Question 1) that OHA provide "estimates of the emission rates in grams per second of each of the potential air pollutants" for the Haverhill resource recovery facility. The Board requested that stack emissions be provided for each pollutant and the emissions data be restricted to facilities having similar combustion and air pollution control technology and supported by published documents.

For the potential air pollutants listed in IR Set V (Question 1), OHA provided emission estimates that represented annual average typical emissions, assuming the plant is operational 24 hours per day. These typical emissions were developed from actual emission testing reports that OHA indicated would best represent the Martin GmbH Stoker Combustion System technology and the dry scrubber and electrostatic precipitator (ESP) air pollution control equipment proposed for the OHA facility.

To estimate the Haverhill emission rates, OHA assumed that the stack sampling results from the Zurich Josefstrasse facility in Zurich, Switzerland was representative of typical emissions. OHA stated that the Zurich facility is the most appropriate facility since it employs a Martin GmbH Stoker Combustion System and has a retro-fitted rotary atomizer spray dryer absorber and an efficient electrostatic precipitator. The Zurich incinerator was designed to burn 500 tons per day (TPD) of solid waste. Stack sampling results from the Zurich Compliance Tests, as reported in the 1987 Joy/Niro paper [2], provided emissions of lead, zinc, cadmium, mercury, and particulate matter.

In developing its case for the use of the compliance test results at Zurich Josefstrasse, OHA stated that actual emissions or typical emissions should be used in the health risk assessment and not allowable emissions based on permit limit values. Using the particulate concentrations measured at the Zurich facility (5.0 mg/Nm^3 corrected to 11% O_2) and the design exhaust flow rate for the OHA facility, OHA estimated an annual average particulate matter emission rate of 0.54 grams per second (g/sec) for the Haverhill facility.

This value is five times lower than the particulate matter emission rate of 2.71 g/sec that was used in OHA's "Air Quality Impact Assessment" report. As discussed in Section 3.1.2, this particulate emission rate was based on the OHA particulate matter permit limit of 0.015 gr/dscf corrected to 12% CO_2 . Based on the OHA design exhaust flow rate, the typical emission rate of 0.54 g/sec is equivalent to a stack particulate concentration of 0.003 gr/dscf corrected to 12% CO_2 .

OHA presented emissions data from two Ogden Martin Systems facilities to demonstrate that particulate emissions from a well operated facility using an ESP without a dry scrubber unit can achieve almost the same emissions control as the Zurich facility. While the average of eighteen stack sampling tests at two facilities resulted in a particulate concentration of 0.0055 gr/dscf corrected to 12% CO_2 , only one sampling run measured particulate concentrations lower than the 0.003 gr/dscf corrected to 12% CO_2 value assumed for the OHA risk assessment analysis.

Trace Metals

To estimate the trace metal emission rates that were used in the health risk assessment for the OHA facility, OHA used the same technical approach that was used in their "Air Quality Impact Assessment" report. As before, this approach simply multiplies the particulate emission rate by the trace metal weight percentage to estimate the trace metal emission rate.

The short-term particulate matter emission rate was assumed to equal 2.71 g/sec based on the permit limit of 0.015 gr/dscf corrected to 12% CO_2 . The annual average particulate emission rate, which was stated to represent typical emissions from the OHA facility, was estimated to be 0.54 g/sec. This emission rate equates to a particulate loading of approximately 0.003 gr/dscf corrected to 12% CO_2 and is five times lower than the DEQE permit limit. Table 3-3 summarizes the stack emission rates that were used in the health risk assessment for the proposed OHA facility.

TABLE 3-3

SUMMARY OF STACK EMISSION RATES
USED IN RISK ASSESSMENT ANALYSIS
FOR PROPOSED OGDEN HAVERHILL FACILITY
(November 1987)

COLUMNS	[A]	[B]	[C]
<u>Pollutant</u>	<u>Weight % Of Particulate Emissions (%)</u>	<u>Emission Rate (g/sec)</u>	<u>Emission Rate Reference</u>
Particulate Matter	1.00E+02	5.40E-01	Zurich Josefstrasse (Stack Test - 1986)
Arsenic (As)	5.30E-02	2.86E-04	Kirsch (Max. of 7 German Plants)
Cadmium (Cd)	4.07E-01	2.20E-03	Zurich Josefstrasse (Stack Test - 1986)
Nickel (Ni)	2.12E+00	1.14E-02	Sheridan Avenue (Maximum - 6 Tests)
Lead (Pb)	8.60E+00	4.64E-02	Zurich Josefstrasse (Stack Test - 1986)
Chromium (Cr)	4.30E+00	2.32E-02	Munich North (Maximum)
Chromium VI	4.30E-03	2.32E-05	Cr VI = 0.001 x Cr (Marion County)
2,3,7,8 TCDD (*) Toxic Equivalents	-	5.84E-08	Zurich Josefstrasse (Removal Efficiencies from Reference [5])
Corrected (**) 2,3,7,8 TCDD Toxic Equivalents	-	7.71E-08	Zurich Josefstrasse (Removal Efficiencies from Reference [5]) Corrected to U.S. EPA toxic equivalents.

(*) Total dioxin/furan concentration expressed in terms of 2,3,7,8 TCDD toxic equivalents, which account for the toxicity of each isomer or congener group as used in OHA's health risk assessment.

(**) Total dioxin/furan concentration expressed in terms of 2,3,7,8 TCDD toxic equivalents, which account for the toxicity of each isomer or congener group as based on the U.S. EPA method [11].

Note: Exponential format used - e.g., 5.30E-02 is equal to 5.30×10^{-2} is equal to 0.053.

Using the same weight percentage of particulate emissions for arsenic that was used in the air quality assessment (Table 3-2, Column A), the arsenic emission rate proposed for use in the health risk assessment was approximately five times lower than the emission rate used in the air quality assessment.

For cadmium and lead, OHA used the weight percentages measured in the compliance tests at the Zurich Josefstrasse facility. By comparing the weight percentages for both metals as summarized in Tables 3-3 (Column A), the weight percentages measured at the Zurich Josefstrasse facility were found to be slightly higher than the maximum weight fractions reported in Appendix A of OHA's "Air Quality Impact Assessment." Using the higher weight percentage value but a particulate emission rate five times smaller, the cadmium emission rate (representing typical emissions) was approximately two times smaller than the emission rate used in the air quality study. Using the measured lead weight percentage at the Zurich facility and the typical particulate emission rate of 0.54 g/sec, the lead emission rate used in the health risk assessment was approximately 3.6 times lower than the lead emission rate used in the air quality study.

Using the same weight percentage for chromium that was used in the air quality assessment, the chromium emission rate used in the health risk assessment was five times lower than the value used in the air quality assessment. Total chromium consists primarily of two valence states, trivalent (Cr III) and hexavalent (Cr VI). Hexavalent chromium is considered by EPA to be carcinogenic while the trivalent state is not.

Emissions tests conducted at the Marion County Resource Recovery Facility measured total and hexavalent chromium at the inlet and outlet of the air pollution control equipment. The hexavalent chromium measured at the outlet of the baghouse was at or below the detection limit. However, the outlet detection limit for chromium VI was 10 percent of the total chromium. The hexavalent chromium measured at the inlet of the air pollution control equipment was less than one-tenth of one percent of the total chromium. Based on the inlet (uncontrolled) emissions tests conducted at the Marion County Resource Recovery Facility, OHA assumed that the weight percentage of chromium VI was less than one-tenth of one percent of the weight percentage of total chromium. As shown in Table 3-3 (Column B), the chromium VI emission rate used in the health risk assessment is 1,000 times lower than the total chromium emission rate.

The assumptions used by OHA to estimate chromium VI emissions from the Haverhill facility is not consistent with the approach used by Ogden Martin Systems in a health risk assessment completed in April 1987 for the Milliken Waste-To-Energy Project [10]. Using the same Marion County data discussed above, Ogden assumed as an upperbound estimate that 10 percent of the total chromium was the hexavalent form (chromium VI). As a worst-case estimate, Ogden assumed that 1/7th (14.3%) of the total chromium present is in the hexavalent form. This worst-case health risk assumption was prescribed by the California Air Resources Board (CARB).

Dioxins/Furans

To estimate the emissions of dioxins and furans from the Haverhill facility, OHA used the emissions data from the Zurich Josefstrasse facility as determined by the Swiss EMPA organization. These uncontrolled emissions were adjusted by the specific congener group reductions reported for a spray dryer absorber/ESP system [3]. Based on this report, a 76 percent removal efficiency for dioxins and furans was calculated for the OHA facility. For use in the health risk assessment, the total dioxin/furan emission rate expressed in terms of 2,3,7,8 TCDD toxic equivalents (as shown in Table 3-3, Column B) was calculated to be $5.84\text{E-}08$ grams per second (g/sec) based on the U.S EPA toxicity scheme.

In developing the emission rates as requested by the Board in IR Set V and used in the health risk assessment, it appears that OHA made an error in estimating the 2,3,7,8 TCDD toxic equivalents for the OHA facility. The 2,3,7,8 TCDD toxic equivalence factors, which account for the toxicity of each isomer or congener, used by OHA do not match the U.S. EPA values as published in April 1986 [11]. The toxicity weighting factors used by OHA appear to come from an interim workshop position document prepared in 1985 [13]. As shown in Table 3-3 (Column B), the 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA toxicity scheme [11] results in an emission rate of $7.71\text{E-}08$ g/sec. This emission rate is approximately 32 percent higher than the emission rate used by OHA in the risk assessment study conducted in 1987.

During the proceedings, OHA reported that a recent test had been conducted to measure the removal efficiency for dioxins/furans at the Zurich Josefstrasse facility. Based on this test, OHA stated that they believed the removal efficiency for dioxins/furans would be greater than 90 percent. Accordingly, OHA requested that the health risk due to emissions from the OHA stack be lowered on the assumption that the Haverhill facility's performance will equal that described at the Zurich facility.

The Board agreed that if the OHA facility could remove 90 percent of the dioxins/furans, the health risk associated with the stack emissions would be significantly reduced from the risk levels estimated with the 76 percent removal efficiency. However, the Board declined to accept the Zurich report stating that only the abstract had been submitted to the Board. Given the Zurich report's significant increase in removal efficiencies from previous OHA and industry estimates, the OHA's proposed use of an increased dioxins/furans removal efficiency in the health risk assessment was rejected.

OHA has provided the Task Force with additional information on the stack testing conducted at the Zurich Josefstrasse facility. In addition, OHA has provided the Task Force with extensive documents and information describing the Zurich Josefstrasse facility and qualifications of the company (dk Teknik) that conducted the actual testing. As discussed in

Section 3.1.1, a comparison between the similarities and differences between the Zurich facility and the proposed OHA facility indicate that the Ogden incinerators and air pollution control systems at both sites are similar.

dk-Teknik performed stack measurements at the Zurich facility to determine the dioxins/furans concentrations in the flue gas before and after the control equipment that consist of a spray dryer absorber with lime slurry injection and an electrostatic precipitator. Based on the reported results from four samples, the average removal efficiencies for toxic equivalent dioxins and furans (TEDF) based on Eadon's toxicity scheme (remember that the risk assessment analysis used the U.S. EPA toxicity scheme) was approximately 90 percent.

3.1.4 Stack Emissions from Millbury Resource Recovery Facility

The U. S. Environmental Protection Agency (U.S. EPA) published an advance notice of proposed rulemaking (Federal Register, July 7, 1987) for municipal waste combustors (MWC). After reviewing data from existing MWC facilities and gathering additional data where necessary to support regulations development, the U.S. EPA will establish emission standards for new and modified MWC facilities under Section 111(b) of the Clean Air Act and issue emission guidelines for existing MWC facilities under Section 111(d) of the Act. The U.S. EPA's Office of Air Quality Planning and Standards (OAQPS) is responsible for reviewing the existing air emission data base and gathering additional data to support regulations development, particularly regarding emerging air pollution control technologies.

The Millbury facility is the first application of a SDA/ESP control system on an MWC in North America. In June 1987, the OAQPS issued operational guidance to the U.S. EPA's Regions stating that good combustion and a spray dryer followed by an efficient particulate collector shall be considered Best Available Control Technology (BACT) for new and modified MWC facilities. Lacking specific emissions data to characterize the performance of an SDA/ESP control system on MWC emissions, the USEPA contracted Entropy Environmentalists, Inc. (Entropy) to conduct an emission testing program on one of two MWC units at the Millbury facility. The specific objectives of the Millbury test program were to determine the control efficiency of an SDA/ESP system and obtain plant operating and continuous emission monitoring data for the periods of emission testing.

During the week of February 8, 1988, Entropy conducted an emission testing program to measure the following pollutants: particulate matter (PM), sulfur dioxide, carbon monoxide, nitrogen oxides, total hydrocarbons, hydrogen chloride, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and specific metals, including arsenic, cadmium, lead, mercury, nickel, and total chromium [4].

In conjunction with the USEPA-sponsored testing program, Entropy also conducted an extensive testing program for Wheelabrator Environmental Systems, Inc. (WES) to quantify specific emissions from Unit Nos. 1 and 2 of the Millbury facility. This test was conducted to meet the conditions of the approved Millbury Permit No. CM-85-IF-001(A) under 310 CMR 700 and in accordance with the state provisions of solid waste law Chapter 21H, Section 5C. The permit limit for particulate matter emissions from the Millbury facility is 0.030 grains per dry standard cubic feet (gr/dscf) corrected to 12% CO₂.

A second compliance testing program was conducted by Entropy from October 31 through November 4, 1988 at the Unit No. 1 ESP outlet [5]. All testing was conducted in accordance with a stack testing protocol prepared for the Millbury facility and approved by the Massachusetts Department of Environmental Quality Engineering (DEQE). DEQE observers witnessed all testing procedures at the site.

Table 3-4 summarizes the results for selected pollutants from the Entropy stack sampling studies conducted in February and November 1988 for the Millbury facility. Only the pollutants that have been reported to be important in the health risk assessment for the Haverhill facility have been included.

During the February 1988 stack sampling period, three sampling tests were performed at each Unit's (Nos. 1 and 2) ESP outlet [4, 6]. The average emission rates for Unit Nos. 1 and 2 and the maximum emission rate for all sampling tests are provided in Table 3-4 for all pollutants in gr/dscf correct to 12% CO₂. In addition, the average and maximum stack emission rates for Unit Nos. 1 and 2 in grams per second have been calculated. The maximum stack emission rate (g/sec) represents the maximum emission rate for all runs at either unit.

Table 3-5 summarizes the PCDD/PCDF emission concentrations for individual isomers and isomer groups for the two sampling periods. In addition, the table provides the results of the total PCDD, total PCDF, total PCDD/PCDF, and 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA's toxicity scheme [11]. All concentrations have been presented in nanograms/dscf (32°F and one atmosphere) and grams per second (g/sec).

As summarized in the information provided in Table 3-1 (Columns A and B), the Haverhill and Millbury facilities are very similar in design and size with comparable state-of-the-art combustion and emission control systems. The measured uncontrolled and controlled PCDD and PCDF concentrations in nanograms per dry standard cubic meter (ng/dscm) corrected to 12% CO₂ (based on the compliance tests in February 1988 at the Millbury facility) are shown in Table 3-6 [6].

As shown in Table 3-6, the removal efficiencies for total PCDD and PCDF emissions was calculated to be 72.8%. Using the U.S. EPA scheme [11] to calculate 2,3,7,8 TCDD toxic equivalents, the removal efficiency calculated based on inlet and outlet concentrations was estimated to be 71.2% for the 2,3,7,8 TCDD toxic equivalents.

TABLE 3-4

SUMMARY OF STACK EMISSION DATA
WHEELABRATOR MILLBURY, INC. RESOURCE RECOVERY FACILITY
MILLBURY, MASSACHUSETTS

Testing Period:	February 1988		November 1988	
	Emission Rate	Emission	Emission Rate	Emission
	(Gr/DSCF)	Rate(*)	(Gr/DSCF)	Rate(*)
Pollutant	@ 12% CO ₂	(g/sec)	@ 12% CO ₂	(g/sec)
Particulate Matter				
UNIT 1 - Average	1.8E-03	1.6E-01	1.8E-03	1.5E-01
UNIT 2 - Average	8.3E-03	6.7E-01	-	-
Maximum - All Runs	19.4E-03	15.6E-01	1.8E-03	1.5E-01
Arsenic (As)				
UNIT 1 - Average	15.1E-07	12.6E-05	7.2E-07	6.1E-05
UNIT 2 - Average	19.4E-07	16.0E-05	-	-
Maximum - All Runs	37.4E-07	30.0E-05	9.4E-07	8.2E-05
Cadmium (Cd)				
UNIT 1 - Average	7.5E-06	6.2E-04	2.8E-06	2.4E-04
UNIT 2 - Average	9.0E-06	7.5E-04	-	-
Maximum - All Runs	17.3E-06	13.9E-04	3.0E-06	2.6E-04
Nickel (Ni)				
UNIT 1 - Average	< 9.7E-06	8.4E-04	ND	ND
UNIT 2 - Average	< 6.7E-06	5.4E-04	-	-
Maximum - All Runs	25.0E-06	21.9E-04	ND	ND
Lead (Pb)				
UNIT 1 - Average	11.8E-05	9.8E-03	3.8E-05	3.2E-03
UNIT 2 - Average	14.0E-05	11.4E-03	-	-
Maximum - All Runs	30.2E-05	24.2E-03	4.4E-05	3.8E-03
Chromium (Cr)				
UNIT 1 - Average	4.2E-05	3.7E-03	0.3E-05	0.3E-03
UNIT 2 - Average	2.0E-05	1.7E-03	-	-
Maximum - All Runs	12.0E-05	10.5E-03	0.4E-05	0.3E-03
Chromium VI				
UNIT 1 - Average	-	-	ND	ND
UNIT 2 - Average	-	-	-	-
2,3,7,8 TCDD Toxic Equiv.(**)				
UNIT 1 - Average	-	-	-	1.7E-08
UNIT 2 - Average	-	1.2E-08	-	-

(*) Emission rates (grams/second) from only one unit (Unit No. 1 or 2).

(**) 2,3,7,8 TCDD Toxic Equivalents based on U.S. EPA method [11].

(ND) Not detected or did not meet all qualitative identification criteria.

(-) No measurement taken.

(<) Less than the value shown.

TABLE 3-5

SUMMARY OF PCDD/PCDF EMISSION DATA
WHEELABRATOR MILLBURY, INC. RESOURCE RECOVERY FACILITY

Testing Period	-----February 1988-----		-----November 1988-----	
PCDD/PCDF	Emission Rate	Emission	Emission Rate	Emission
ESP Outlet	(Nanogram/DSCM)	Rate	(Nanograms/DSCF)	Rate
	@ 32°F, 1 atm.	(g/sec)	@ 32°F, 1 atm.	(g/sec)
	Unit No. 1	Unit No. 1	Unit No. 2	Unit No. 2
Dioxins (PCDD)				
Total MCDD	ND	ND	ND	ND
Total DCDD	5.6E-02	2.5E-09	ND	ND
Total TriCDD	4.1E-01	1.8E-08	2.0E-02	8.2E-10
2378-TCDD	ND	ND	1.2E-01	5.0E-09
Other TCDD	9.6E-01	4.3E-08	7.9E-01	3.3E-08
12378-PCDD	8.5E-02	3.8E-09	1.5E-01	6.1E-09
Other PCDD	8.7E-01	3.8E-08	3.3E-01	1.4E-08
123478-HxCDD	9.9E-02	4.4E-09	9.7E-02	4.0E-09
123678-HxCDD	1.9E-01	8.4E-09	1.4E-01	5.9E-09
123789-HxCDD	2.6E-01	1.1E-08	1.6E-01	6.9E-09
Other HxCDD	1.4E+00	6.2E-08	9.6E-01	4.0E-08
1234678-HpCDD	9.5E-01	4.2E-08	8.9E-01	3.7E-08
Other HpCDD	7.9E-01	3.5E-08	1.3E+00	5.3E-08
OCDD	4.2E+00	1.8E-07	3.6E+00	1.5E-07
Total PCDD	1.0E+01	4.5E-07	8.5E+00	3.5E-07
Furans (PCDF)				
Total MCDF	ND	ND	ND	ND
Total DCDF	1.7E+00	7.5E-08	ND	ND
Total TriCDD	9.3E+00	4.1E-07	2.8E+00	1.1E-07
2378-TCDF	5.3E-01	2.3E-08	4.8E-01	2.0E-08
Other TCDF	1.3E+01	5.6E-07	9.4E+00	3.9E-07
12378-PCDF	3.7E-01	1.6E-08	6.4E-01	2.6E-08
23478-PCDF	4.7E-01	2.1E-08	4.2E-01	1.8E-08
Other PCDF	6.2E+00	2.7E-07	6.2E+00	2.6E-07
123478-HxCDF	1.2E+00	5.4E-08	7.6E-01	3.2E-08
123678-HxCDF	6.2E-01	2.8E-08	4.5E-01	1.9E-08
234678-HxCDF	3.9E-01	1.7E-08	4.8E-01	2.0E-08
123789-HxCDF	7.0E-02	3.1E-09	ND	ND
Other HxCDF	3.8E+00	1.7E-07	2.2E+00	8.9E-08
1234678-HpCDF	1.7E+00	7.4E-08	2.9E+00	1.2E-07
1234789-HpCDF	2.8E-01	1.2E-08	1.5E-01	6.1E-09
Other HpCDF	1.3E+00	5.8E-08	1.2E+00	4.8E-08
OCDF	2.6E+00	1.1E-07	2.1E+00	8.7E-08
Total PCDF	4.3E+01	1.9E-06	3.0E+01	1.2E-06
Total PCDD/PCDF	5.3E+01	2.4E-06	3.9E+01	1.6E-06
2,3,7,8 TCDD Toxic(*)	-	1.2E-08	-	1.7E-08

Equivalents

(*) The total dioxin/furan concentrations are expressed in terms of 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA method [11].

(ND) Not detected or did not meet all qualitative identification criteria.

TABLE 3-6

SUMMARY OF PCDD/PCDF ISOMER CONTROL EFFICIENCY
 WHEELABRATOR MILLBURY, INC. RESOURCE RECOVERY FACILITY
 February 1988 Emissions Data

PCDD/PCDF Isomer	Average Concentration Nanograms/DSCM (corrected to 12% CO ₂)		2,3,7,8 TCDD	Average 2,3,7,8 TCDD Toxic Equivalents (ng/DSCM @ 12% CO ₂)	
	Inlet	Outlet	Toxic Equiv.	Inlet	Outlet
	Uncontrolled	Controlled	Factor	Uncontrolled	Controlled
Dioxins (PCDD)					
Total MCDD	ND	ND	0.0E+00	0.0E+00	0.0E+00
Total DCDD	1.5E+00	8.6E-02	0.0E+00	0.0E+00	0.0E+00
Total TriCDD	4.8E+00	6.7E-01	0.0E+00	0.0E+00	0.0E+00
2378-TCDD	3.6E-01	8.6E-02	1.0E+00	3.6E-01	8.6E-02
Other TCDD	4.8E+00	1.2E+00	1.0E-02	4.9E-02	1.2E-02
12378-PCDD	6.0E-01	1.4E-01	5.0E-01	3.0E-01	6.8E-02
Other PCDD	4.6E+00	1.0E+00	5.0E-03	2.3E-02	5.0E-03
123478-HxCDD	6.1E-01	1.7E-01	4.0E-02	2.4E-02	7.0E-03
123678-HxCDD	9.1E-01	2.7E-01	4.0E-02	3.6E-02	1.1E-02
123789-HxCDD	1.9E+00	4.1E-01	4.0E-02	7.5E-02	1.6E-02
Other HxCDD	7.8E+00	1.8E+00	4.0E-04	3.0E-03	1.0E-03
1234678-HpCDD	4.8E+00	1.5E+00	1.0E-03	5.0E-03	1.0E-03
Other HpCDD	4.6E+00	1.2E+00	1.0E-05	0.0E+00	0.0E+00
OCDD	1.3E+01	7.1E+00	0.0E+00	0.0E+00	0.0E+00
Total PCDD	5.1E+01	1.6E+01		8.7E-01	2.1E-01
Furans (PCDF)					
Total MCDF	5.0E-01	ND	0.0E+00	0.0E+00	0.0E+00
Total DCDF	2.4E+01	2.2E+00	0.0E+00	0.0E+00	0.0E+00
Total TriCDD	8.4E+01	1.3E+01	0.0E+00	0.0E+00	0.0E+00
2378-TCDF	2.2E+00	7.2E-01	1.0E-01	2.2E-01	7.2E-02
Other TCDF	5.1E+01	1.7E+01	1.0E-03	5.1E-02	1.7E-02
12378-PCDF	2.1E+00	6.4E-01	1.0E-01	2.1E-01	6.4E-02
23478-PCDF	2.2E+00	7.9E-01	1.0E-01	2.2E-01	7.9E-02
Other PCDF	2.5E+01	7.9E+00	1.0E-03	2.5E-02	8.0E-03
123478-HxCDF	5.4E+00	1.8E+00	1.0E-02	5.4E-02	1.8E-02
123678-HxCDF	2.8E+00	9.1E-01	1.0E-02	2.8E-02	9.0E-03
234678-HxCDF	2.6E+00	9.8E-01	1.0E-02	2.6E-02	1.0E-02
123789-HxCDF	1.3E-01	1.1E-01	1.0E-02	1.0E-03	1.0E-03
Other HxCDF	1.6E+01	5.1E+00	1.0E-04	2.0E-03	1.0E-03
1234678-HpCDF	6.0E+00	2.6E+00	1.0E-04	1.0E-03	0.0E+00
1234789-HpCDF	5.2E-01	7.2E-01	1.0E-04	0.0E+00	0.0E+00
Other HpCDF	2.9E+00	1.9E+00	1.0E-05	0.0E+00	0.0E+00
OCDF	2.3E+00	4.4E+00	0.0E+00	0.0E+00	0.0E+00
Total PCDF	2.3E+02	6.0E+01		8.4E-01	2.8E-01
Total PCDD/PCDF	2.8E+02	7.6E+01		1.7E+00	4.8E-01
Control Efficiency(*)	-	72.8%		-	71.2%

(*) Control efficiencies calculated based on inlet and outlet concentrations corrected to 12% CO₂ using the following: $(C_i - C_o)/(C_i \times 100\%)$.

(ND) Not detected or did not meet all qualitative identification criteria.

3.1.5 Findings of Task 1 Review and Evaluation

In order to compare the stack emissions data used in the OHA's ambient air quality and health risk assessments with stack emissions data from other resource recovery plants, the stack emissions data from the different facilities had to be compared on a standard basis. Based on their direct input into air quality dispersion models, which are used to estimate the impact of each pollutant on human receptors, the pollutant emission rates from the different facilities were reported in the units of grams per second (g/sec). Table 3-7 (Column A) summarizes the stack emission rates used in the risk assessment analysis for the proposed OHA facility. Only the pollutants that have been found to be important in the health risk assessment have been listed.

Based on the two stack sampling tests conducted at the Millbury facility in February and November 1988, the average (Units 1 and 2) and maximum (all tests) emission rates for the key pollutants have been summarized in Table 3-4. The average and maximum stack emission rates (g/sec) shown represent stack emission rates per unit.

Table 3-5 summarizes the results of the dioxins/furans (PCDD/PCDF) stack emissions tests at the Millbury facility for the two studies conducted in 1988. The total PCDD, PCDF, and PCDD/PCDF emission rates, in grams per second, are provided and represent the average (all runs) emission rate for Unit 1 (February 1988 period) and Unit 2 (November 1988 period). The total PCDD/PCDF concentrations in terms of 2,3,7,8-TCDD toxic equivalents based on the U.S. EPA's toxicity scheme are shown for each sampling period. Table 3-6 summarizes the removal efficiencies for PCDD and PCDF with the removal efficiency for 2,3,7,8-TCDD toxic equivalents calculated to be 71.2% for the February 1988 test.

The average Millbury stack emission rates per unit are based on the average of all sampling tests conducted on Units 1 and 2 during both testing periods. To estimate the emission rates from the OHA facility, the average Millbury pollutant emission rates per unit have been increased by a 2.2 scaling factor to account for the fact that the Ogden Haverhill facility has two units and is designed to handle 825 tons per day (TPD) per unit and the Millbury facility only 750 TPD per unit. This represents a 220 percent increase in the Millbury emission rate per unit ($2 \text{ Units} \times 825 \text{ TPD} / 750 \text{ TPD} = 2.20$). Table 3-7 compares the stack emission rates used in the OHA's health risk assessment (Column A) with the stack emission rates obtained from scaling the stack sampling results at the Millbury facility (Columns B and C).

The maximum Millbury stack emission rates per unit are based on the maximum emission rate measured for all sampling runs for Units 1 and 2. To account for the size differences between the two facilities, the maximum Millbury emission rates per unit have been multiplied by a 2.2 scaling factor.

The Board requested that upper level estimates be used where site-specific data is not available in order to guard against underestimation of risk.

TABLE 3-7

COMPARISON BETWEEN STACK EMISSION RATES
USED IN OGDEN RISK ASSESSMENT ANALYSIS
AND MILLBURY RESOURCE RECOVERY FACILITY

COLUMNS	[A]	[B]	[C]
Pollutant	Risk Assessment Emission Rate Ogden (Haverhill) <u>(g/sec)[+]</u>	Average Scaled Emission Rate Using Millbury Data (g/sec)[*]	Maximum Scaled Emission Rate Using Millbury Data (g/sec)[**]
Particulate Matter	0.54	0.72	3.42
Arsenic (As)	2.9E-04	2.5E-04	6.6E-04
Cadmium (Cd)	2.2E-03	1.2E-03	3.0E-03
Nickel (Ni)	11.3E-03	< 1.0E-03	4.8E-03
Lead (Pb)	4.6E-02	1.8E-02	5.3E-02
Chromium (Cr)	2.3E-02	0.4E-02	2.3E-02
Chromium VI	2.3E-05	-	-
2,3,7,8 TCDD Toxic Equivalents	5.8E-08	3.1E-08	3.7E-08

Notes:

[+] Total stack emission rates (g/sec) used in the Haverhill Risk Assessment Analysis [See Table 3-3]. OHA calculation of 2,3,7,8 TCDD Toxic Equivalents not based on U.S. EPA scheme [11].

[*] Average stack emission rates (g/sec) based on all stack sampling runs from Millbury facility and scaled to the size of the Ogden Haverhill facility (2 Units x 1650 TPD/1500 TPD = 2.20).

[**] Maximum stack emission rates (g/sec) based on highest stack sampling measurement at Millbury facility and scaled to the size of the Ogden Haverhill facility (2 Units x 1650 TPD/1500 TPD = 2.20).

(<) Less than the value shown.

The average scaled Millbury stack emission rates (g/sec) shown in Table 3-7 (Column B) represent an annual average emission rates of pollutants from the OHA facility. The maximum scaled Millbury stack emission rates (g/sec) provided in Table 3-7 (Column C) represent an upper limit of the estimated emissions from the OHA facility. With the health risk assessment analysis based on annual average air quality concentrations and deposition rates, the average scaled emissions rates (Table 3-7, Column B) are felt to better represent typical annual average emissions and compared with the emission rates (Column A) used in the Ogden stack health risk assessment.

As stated in Section 3.1.3, OHA used a particulate emission rate of 0.003 gr/dscf corrected to 12% CO₂ in the risk assessment analysis. The stack particulate emission rates measured at the Millbury facility had an average emission rate of 0.004 gr/dscf for all runs (Unit Nos. 1 and 2), an average emission rate of 0.008 gr/dscf for the February 1988 tests on Unit 2, and a maximum emission rate of 0.019 gr/dscf corrected to 12% CO₂.

As shown in Table 3-7, the total stack particulate matter emission rate used in the health risk assessment for the OHA facility is more than 30 percent lower than the average scaled Millbury emission rate and more than six times lower than the maximum scaled emission rate based on the stack testing data measured at the Millbury facility. However, even though it appears that the particulate emission rate from the OHA facility was underestimated for the health risk assessment, it should be noted that no credit has been given to the fact that the OHA facility has a four-field ESP system while the Millbury facility has a three-field ESP system. As shown in Table 3-1, the specific collection area (which is normally considered to be directly related to particulate removal efficiency) is 30 percent larger for the OHA ESP system than the Millbury system. In addition, the OHA particulate emission limit (0.015 gr/dscf) is one-half that of the Millbury facility (0.030 gr/dscf).

Health risk assessments are based on the cancer potency of the specific pollutants, such as the trace metals, emitted from the facility. Because the assessment relies on the reported toxicity of a specific pollutant, the health risk is not determined based solely on the total stack particulate emissions. However, as discussed in Section 3.1.3, the trace metal emission rates used in the health risk assessment were estimated by multiplying the reported trace metal weight percent of particulates by the total stack particulate emission rate.

In comparing the pollutant emission rates shown in Table 3-7, the trace metal emission rates used in the Haverhill health risk assessment (Column A) are very similar to the average scaled-Millbury emissions data (Column B) with all pollutant emission rates greater than the average stack emission rates calculated from the Millbury sampling tests. With the Board accepting the use of expected typical emissions in the health risk assessment, the trace metal emission rates used in the stack health risk assessment (with the exception of chromium VI) appear to be reasonable based on a comparison with the scaled stack emissions data from the Millbury facility.

In the health risk assessment analysis, OHA assumed that the hexavalent chromium (VI) emission rate is less than one-tenth of one percent of the total chromium emission rate. The assumptions used by OHA to estimate chromium VI emissions from the Haverhill facility is not consistent with the approach used by Ogden in a health risk assessment completed for the Milliken Waste-To-Energy Project [10]. Using the same Marion County data that was used in the OHA study, Ogden assumed as an upperbound estimate that 10 percent of the total chromium was the hexavalent form (chromium VI). As a worst-case estimate, Ogden assumed that 1/7th (14.3%) of the total chromium present is in the hexavalent form.

In the health risk assessments conducted for the Los Angeles City Energy Recovery and Stanislaus projects, it was assumed that 10 percent of the total chromium emissions were chromium VI. In health risk assessments conducted in California over the past few years, chromium VI was conservatively estimated to range from 5 to 14 percent of total chromium.

A paper presented at the June 1987 Air Pollution Control Conference [44] on the chemical analysis of the form of chromium in various environmental samples suggested using a range of one to five percent of total chromium as an estimate of the chromium VI emissions. In addition, recent tests indicate that the measurement method is subject to instrument artifact resulting in a possible underestimation of chromium VI.

While the chromium VI emission rate estimated by this assumption may be achievable with the air pollution control equipment installed at the OHA facility, the use of one-tenth of one percent of total chromium to estimate chromium VI emissions is not consistent with other health risk assessment studies. Based on this information, OHA's assumption that the chromium VI emission rate is less than one-tenth of one percent of the total chromium emission rate may result in an underestimate of the health risk due to chromium VI emissions.

To estimate the controlled emissions of dioxins and furans from the Haverhill facility, OHA assumed a 76 percent removal efficiency. In June 1988, OHA reported that recent tests conducted at the Zurich Josefstrasse facility measured removal efficiency for dioxins/furans greater than 90 percent. The stack test measurements conducted at the Zurich Josefstrasse facility indicate removal efficiencies for toxic equivalent dioxins and furans (TEDF) based on Eadon's toxicity scheme greater than 90 percent. However, as shown in Table 3-6, the removal efficiencies at the Millbury facility was measured to be only 73 percent for total PCDD/PCDF and 71 percent for the 2,3,7,8 TCDD toxic equivalents.

A paper presented at the Industrial Gas Cleaning Institute [7] in November 1988 on the performance of emissions control systems on municipal waste combustors reported that spray dryer absorber/fabric filter (SDA/FF) systems were more effective in controlling PCDD and PCDF emissions than the spray dryer absorber/ESP (SDA/ESP) system as operated at the Millbury

facility. While the SDA/FF systems tested attained average PCDD/PCDF removal efficiencies greater than 90 percent, the Millbury SDA/ESP system was reported to remove less than 70 percent of the PCDD/PCDF emissions. Based on these results, the use of the Zurich Josefstrasse's higher removal efficiency to further reduce the dioxins/furans emission estimates is not recommended. However, it can be expected that dioxin/furan emission rates would be better estimated by the average scaled-Millbury data (Table 3-7, Column B) because of the comparability of the two facilities. The dioxin/furan emissions from the OHA facility may indeed be even lower than the average emission rates based on the Millbury data because of the larger more efficient control equipment at the OHA facility.

The task set before the Board was to determine whether the pollutant emissions from the OHA facility will present a threat to public health, safety, or the environment. To assist the Board in its evaluation, a quantitative health risk assessment of emissions from the OHA facility, based on accepted scientific protocols, was requested. Based on a review of the Record by the Task Force, the stack health risk assessment analyses conducted by OHA and the Board's consultants varied by a factor of nearly four due to a number of technical issues.

After several rounds of submittals and reviews, OHA submitted its final risk assessment to the Board [15] in June 1988. As shown in Table 3-8 (Column B), the estimate of risk due to stack emissions from the proposed OHA facility was calculated to be less than four in a million with emissions of arsenic and 2,3,7,8 TCDD toxic equivalents each accounting for almost one-half of the estimated risk. The final risk due to stack emissions from the proposed OHA facility was estimated by the Board's consultants [14] to be over 14 in a million (Table 3-8, Column A) with almost 85 percent of the risk due to the 2,3,7,8 TCDD toxic equivalent emissions from the OHA stack.

The differences between the two health risk estimates made by the Board's and OHA's consultants were mainly due to the four technical issues listed below:

- o Half-life of dioxins in soil
- o Dioxins/furans emission rates
- o Dioxin and arsenic potencies
- o Deposition rates of organics (i.e., dioxins and furans)

With the above technical issues not completely resolved by the Board and OHA, the Task Force has made an attempt to extrapolate the findings of this study to the stack health risk conclusions found in the Record.

Half-life of Dioxins in Soil

OHA objected to the use of a uniform 17-year half-life of dioxins in the soil in the risk assessment as conducted by the Board's consultants. OHA proposed that the half-lives of the each isomer of dioxins should be used and determined that a 12-year half-life is more appropriate as a composite value representing the different isomers.

TABLE 3-8

COMPARISON BETWEEN HEALTH RISK ASSESSMENTS
DUE TO STACK EMISSIONS FROM OGDEN HAVERHILL FACILITY

COLUMNS	[A]	[B]
<u>Pollutant</u>	<u>Total Potential Lifetime Cancer Risks in a Million Board's Consultants [*]</u>	<u>Total Potential Lifetime Cancer Risks in a Million Ogden's Consultants [**]</u>
INORGANIC COMPOUNDS		
Arsenic (As)	1.7	1.7
Cadmium (Cd)	0.1	0.1
Chromium VI	< 0.01	< 0.01
Nickel (Ni)	0.1	0.1
ORGANIC COMPOUNDS		
2,3,7,8 TCDD Toxic Equivalents	11.9	1.5
Polychlorinated Biphenyls (PCBs)	< 0.01	< 0.01
Chlorobenzene	< 0.10	< 0.01
Chlorophenol	< 0.01	< 0.01
Benzo(a)pyrene	< 0.10	< 0.10
Total Potential Lifetime Cancer Risks in a Million	14.1	3.5

[*] Total risk due to stack emissions from the proposed OHA facility as determined by Board's consultants [14].

[**] Total risk due to stack emissions from the proposed OHA facility as determined by the OHA's consultants [15].

After reviewing objections raised by OHA's consultants on the the half-life of dioxin in the soil, the Board reduced their consultants' stack emissions health risk assessment by 2 in a million to reflect the risk attributed to this factor. Based on the information available to the Task Force, the Board's most recent conclusion on the health risk attributable solely to stack emissions from the proposed OHA facility is 12 in a million, as predicted at the point of maximum impact (PMI).

If the estimated stack risks shown in Table 3-8 are adjusted to account for this decision made by the Board, the range for the health risk due to stack emissions calculated by OHA and the Board's consultants would equal four and 12 in a million, respectively.

Dioxins/Furans Emission Rates

As stated above, OHA had initially assumed a dioxins/furans removal efficiency of approximately 76 percent for the OHA facility. In June 1988, OHA requested that the Board consider new technical information that indicated that the air pollution control equipment installed at the Haverhill site was capable of achieving a dioxins/furans removal efficiency greater than 90 percent. Based on the information supplied by OHA and a review of the dioxins/furans removal efficiency data from the Millbury facility, the Task Force rejects the use of the increased dioxins/furans removal efficiency in the health risk assessment. Therefore, no change is necessary for the estimated stack risks shown in Table 3-8 due to this issue.

Based on discussions with the Board's consultants, the 2,3,7,8 TCDD toxic equivalence factors used in the stack health risk assessment were assumed to be based on the U.S. EPA toxicity scheme published in April 1986 [11]. The toxicity weighting factors used by OHA appear to come from an interim working document prepared in 1985. As shown in Table 3-3 (Column B), the 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA toxicity scheme results in an emission rate more than 32 percent higher than the emission rate used by OHA in the risk assessment conducted in 1987. However, the 2,3,7,8 TCDD toxic equivalent emission rate used in the OHA stack risk assessment (Table 3-7, Column A) is almost twice as high as the emission rate based on the average scaled-Millbury stack test data (Table 3-7, Column B).

If the estimated stack risks shown in Table 3-8 are adjusted to reflect the higher 2,3,7,8 TCDD toxic equivalents emission rate based on the U.S. EPA toxicity scheme (Table 3-3, Column B), the health risk due to stack emissions calculated by OHA and the Board's consultants would increase to a range between four to over 17 in a million. If the lower 2,3,7,8 TCDD toxic equivalents emission rate based on the average scaled-Millbury stack test data (Table 3-7, Column B) is used in the stack health risk assessment, the total potential lifetime cancer risks would range between three and nine in a million.

New Arsenic and Dioxin Potencies

In its final risk assessment analysis submitted to the Board [15], OHA recalculated the risk due to stack emissions using the U.S. EPA's proposed revisions to the cancer potencies of arsenic and dioxin. Based on draft reports [16, 17] published in November 1987, the U.S. EPA has made a preliminary determination that the arsenic and dioxin potencies be reduced by a factor of 10 and 17, respectively. The U.S. EPA analysis [17] based on a linearized multi-stage model estimated that the carcinogenic potency for ingested arsenic was approximately ten times lower than the initial analysis conducted in 1984. With the lower arsenic potency now approved by EPA, the risk associated with ingested arsenic will reduce the estimated stack risk due to arsenic emissions to less than one in a million.

Lower dioxin potency values were reported by the U.S. EPA [16] based on the evidence that dioxin acts as a promotor, rather than an initiator, and that it exhibits a threshold carcinogenic mechanism, as well as the continuing lack of evidence linking dioxin to cancer in humans. With this new evidence, U.S. EPA is considering reducing the current dioxin potency value by a factor of 17. At this time, the U.S. EPA has not finalized these recommendations for dioxins. Therefore, no adjustments are warranted to the estimated stack risks for dioxins shown in Table 3-8.

Deposition Rates

The major differences in the estimated risks due to stack emissions from the OHA facility as shown in Table 3-8 are due to the deposition modeling approaches used by OHA and the Board's consultants.

The calculation of pollutant deposition rates from the air to the soils and surface waters around the facility is an important component of the stack health risk assessment. In the instructions specified in IR Set V, the Board's consultants requested that deposition velocities be calculated using the semi-empirical approach developed by Sehmel and programmed by the California Air Resources Board [25]. After correcting for initial errors made in following the Board's instructions, OHA consultants calculated deposition velocities using Sehmel's method, which uses wind speed, atmospheric stability, particle size, and particle density to calculate hourly deposition velocity.

Using information provided by OHA in its response to IR Set V, the Board's consultants could only verify the deposition velocity calculations when a surface roughness of one centimeter was used as input to the CARB code. In addition, the deposition rate of dioxins/furans were calculated by the Board's consultants in the vapor and solid phases assuming that 70 percent of the dioxin/furan is in the gaseous phase and 30 percent in the particulate phase. With this assumption, the deposition rate calculated by the Board's consultants for organic pollutants was over ten times higher than the deposition rate calculated by the OHA consultants. After reviewing the additional evidence and affidavits presented by OHA's technical experts, the Board's consultants still maintained that their deposition rate calculation for organic (dioxins/furans) was credible. The Task Force did not conduct any deposition analyses to verify either parties calculations.

3.2 TASK 2: Review and Evaluation of Ash Emissions Air Quality Assessment

3.2.1 Determination of Fugitive Ash Emission Rates

The Board requested in Information Request (IR) Set III-A that OHA estimate the hourly fugitive air emissions of ash from the following sources at the OHA facility under full load steady-state operating conditions:

- (1) Ash conveyor systems under the air pollution control equipment, the boiler components and the grate.
- (2) Ash loading of trucks
- (3) Ash trucks traveling to Landfill
- (4) Ash truck dumping and pile maintenance activities at the Landfill
- (5) Fugitive dust due to resuspension of ash at Landfill

The hourly fugitive ash emissions from these sources were estimated following instructions as prepared by the Board's consultant. As specified in IR Set III-A, the estimate of ash emissions from the above sources were calculated from the empirical equations given in U.S. EPA's AP-42 [19]. In the initial analysis, the hourly emissions were estimated as follows:

Conveyor Transfer Points

The emissions factor equation given in AP-42 for continuous drop operations was used to estimate the emissions from the ash conveyor systems.

$$E = \frac{K (0.0018) (S/5) (U/5) (H/10)}{(M/2)^2} \quad (\text{lb/ton}) \quad (3-1)$$

where E - Emission Factor (lb/ton of ash processed)
K - Aerodynamic particle size multiplier (dimensionless)
S - Material silt content (%)
U - Mean wind speed (mph)
H - Drop height (ft.)
M - Material moisture content (%)

Based on data from the Marion County facility [20], a silt content of 13 percent and moisture content of 12.8 percent were assumed. A drop height of 7.5 ft. was assumed based on engineering drawings for the OHA facility. A value of 0.77 for the coefficient K, aerodynamic particle size multiplier, was determined from AP-42 for particle sizes less than 30 microns for continuous drop operations. Using an average wind speed of 12.5 mph based on Boston meteorological data [21], the emission factor for uncontrolled fugitive ash emissions at the conveyor transfer points was estimated to be 1.65×10^{-4} pounds per ton (0.000165 lb/ton) of ash.

For the six transfer points enclosed in the boilerhouse and ash handling buildings, an effective control efficiency of 90 percent was assumed. For the covered conveyor transfer point located between two building, a control efficiency of 50 percent was assumed.

With the proposed OHA facility designed to process 380 tons per day of ash and the assumed control efficiencies for the transfer points, the controlled ash emission rate was calculated to be 0.0029 pounds per hour (lb/hr).

Truck Loading

The AP-42 emission factor equation for "batch-drop" operations was used to estimate the ash emissions due to loading the ash into dump truck using front-end loaders.

$$E = \frac{K (0.0018) (S/5) (U/5) (H/5)}{(M/2) (Y/6)} \quad (\text{lb/ton}) \quad (3-2)$$

where E = Emission Factor (lb/ton of ash processed)
 K = Aerodynamic particle size multiplier (dimensionless)
 S = Material silt content (%)
 U = Mean wind speed (mph)
 H = Drop height (ft.)
 M = Material moisture content (%)
 Y = Dumping device capacity (cubic yards)

Based on data from the Marion County facility [20], a silt content of 13 percent and moisture content of 12.8 percent were assumed. For the front-end loads with a capacity of 7 cubic yards, a drop height of 6.0 ft. was determined from the height of the dump trucks. A value of 0.73 for the coefficient K, aerodynamic particle size multiplier, was determined from AP-42 for particle sizes less than 30 microns for a batch drop operation. Using an average wind speed of 12.5 mph, the uncontrolled emission factor was calculated to be 2.4×10^{-4} pounds per ton (0.00024 lb/ton) of ash.

Since all of the truck loading activity takes place inside the ash handling building, an effective control efficiency of 90 percent was assumed. With the proposed OHA facility designed to process 380 tons per day of ash, the controlled ash emission rate was calculated to be 0.00038 pounds per hour (lb/hr).

Leaks from Trucks Traveling to Ash Monofill

Fugitive emissions of ash escaping from the dump trucks while driving to the Landfill were estimated using the AP-42 emission factor for wind erosion.

$$E = (1.7) \frac{S}{1.5} \frac{365 - P}{235} \frac{f}{15} \quad (\text{lb/day per acre}) \quad (3-3)$$

where E - Emission Factor (lb/day/acre)

S - Material silt content (%)

P - Number of days with 0.25 mm (0.01 inch) of precipitation per year.

f - Percentage of time that the unobstructed wind speed exceeds 5.4 m/s (12 mph) at the the mean pile height.

The frequency of wind speeds greater than 12 mph was determined to be 60 percent based on meteorological data at Logan (Boston) Airport. A silt content of 13 percent was assumed. The number of days with precipitation of more than 0.25 mm (0.01 inch) was assumed to be 180.

The sealed-bottom trucks will be covered with a tarpaulin when in transit between the ash handling building and the monofill area. Based on the assumption that 20 truckloads of ash will be required per day, the total tarpaulin-covered area for all trucks per day was estimated to be 0.072 acres (20 trucks x 7.5 ft. x 21.0 ft.). The tarpaulin-cover on each truck was assumed to result in a fugitive ash control efficiency of 90 percent. Based on the assumption that 20 truckloads will be required per day, the fugitive emission rate due to ash escaping from the trucks was calculated to be 0.014 lb/hr.

Truck Dumping at the Landfill Monofill

Equation 3-2 was used to estimate the ash emissions when the trucks dump the ash into the monofill. The silt and moisture contents were assumed to be 13.0 percent and 12.8 percent, respectively. The capacity of the dump truck was estimated to be 21 cubic yards with an average drop height of 12.0 ft. With an average wind speed of 12.5 mph and an aerodynamic particle size multiplier of 0.73, the emission factor was calculated to be 3.3×10^{-4} pounds per ton of ash.

Based on the expected design rate of 380 tons per day of ash, an estimated ash emission rate of 0.0054 lb/hr was calculated for the truck dumping operation at the monofill.

Wind Erosion of Exposed Ash Surface

Wind erosion of ash in the monofill was estimated following the procedures outlined in Cowherd [21]. Based on this report, nonhomogeneous surfaces impregnated with nonerodible elements are characterized by finite availability of erodible material and, therefore, the crusted surfaces at the ash monofill is regarded as having a "limited reservoir" of erodible particles. For estimating respirable particulate emissions from surface characterized by a "limited reservoir" of erodible material, the following emission factor equation developed by Cowherd [22] was used.

$$E_{10} = (0.83) (f) P(u^+) \frac{(1 - V)}{(PE/50)^2} \quad (\text{mg/m}^2\text{-hr}) \quad (3-3)$$

- where E_{10} - Respirable particulate emission factor ($\text{mg/m}^2\text{-hr}$)
 V - Fraction of contaminated surface area covered by continuous vegetative cover (equals 0 for bare soil)
 f - Frequency of disturbance per month
 u^+ - Observed fastest mile of wind for the period between disturbances (m/sec)
 $P(u^+)$ - Erosion potential, i.e., quantity of erodible particles present on the surface prior to the onset of wind erosion (g/m^2).
 PE - Thornthwaite's Precipitation Evaporation Index used as a measure of average soil moisture content.

The erosion potential (in g/m^2) depends on the fastest observed wind speed for the period between disturbances as follows:

$$\begin{aligned} P(u^+) &= 6.7 (u^+ - u_t), & u^+ > u_t \\ &= 0, & u^+ < u_t \end{aligned} \quad (3-4)$$

where u_t is the erosion threshold wind speed, measured at a typical weather station sensor height of 7 meters. Based on an assumed modal particle size of 4 millimeters (mm) for the ash and the technical information provided in Cowherd, the threshold wind speed was calculated by OHA to be 25.5 meters per sec (m/sec). For surfaces with limited erosion potential, the threshold wind speed represents the wind speed required for initiation of soil erosion. The fastest observed wind speed for Boston (Logan Airport) [23] speed is 25.2 m/s . Since the fastest observed wind speed is less than the 25.2, the erosion potential, $P(u^+)$, is 0 (Equation 3-4) and the emission factor is zero.

With the wind erosion emission factor equal to zero, OHA assumed that no ash emissions would occur from the monofill surface due to resuspension of material. Because the threshold friction velocity at 7 meters (25.5 m/sec) was only marginally larger than the fastest observed wind speed (25.2 m/sec), the Task Force repeated the steps using the assumptions made by OHA and following the procedures outlined in Cowherd [21]. The Task Force calculated a higher threshold friction velocity than that calculated by OHA and, therefore, agreed with OHA's assessment that no fugitive ash emissions should be expected from the monofill surface.

Landfill Maintenance Activity

A bulldozer at the monofill area at the OHA Landfill will spread the ash material after the ash has been dumped into the monofill. The emission factor equation in AP-42 for "traffic on unpaved surfaces" was used to estimate the emissions:

$$E = k (5.9) (S/12) (VS/30) (W/3) (w/4) (365 - P)/P \quad (3-5)$$

where E - Emission Factor (lb/vehicle mile traveled)
k - Particle size multiplier (dimensionless)
S - Material silt content (%)
VS - Mean vehicle speed (mph)
W - Mean vehicle weight (ton)
w - mean number of wheels
P - Number of days with 0.25 mm (0.01 inch) of precipitation per year.

A particle size multiplier of 0.8 was taken from AP-42 for particle sizes less than or equal to 30 micron. As before, a silt content of 13 percent was assumed. The weight of the bulldozer to be used by OHA was estimated to be 35 tons with an average speed estimated to be no more than 3 mph. Since the bulldozer has no wheels, the wheel parameter in the equation was set to a default value of 4. As recommended by the Board, the number of days with more than 0.01 inches of precipitation was assumed to be 180 for the Haverhill area. Based on the above assumptions, the emission factor was calculated to be 1.45 pounds of ash per vehicle mile traveled.

OHA estimated that the bulldozer would make three passes over the monofill area to spread and cover the ash for every 10 truckloads of ash dumped, or twice a day. Based on an exposed area of approximately 1,000 square feet, the distance of a single pass over the area was estimated to be 160 feet. Based on a travel distance of 0.2 miles per day, the estimated ash emission rate was calculated to be 0.012 pounds per hour (lb/hr).

The estimated emissions for the ash handling activities per day, as presented in the OHA's responses to Information Request Set III-A, are as follows:

Conveyor Transfer Points	0.069	lb/day
Truck Loading	0.009	lb/day
Traveling Trucks	0.336	lb/day
Dumping at Monofill	0.130	lb/day
Landfill Maintenance	0.281	lb/day
Wind Erosion at Monofill	<u>0.000</u>	lb/day
Total Screening Emission Rate	0.825	lb/day

3.2.2 Air Quality Modeling of Ash Emissions

The Industrial Source Complex Long-Term Model (ISCLT) was used to estimate the annual average air quality concentrations and deposition rates of ash from the ash handling activities at the OHA facility. The ISCLT model accepts the following source types: stack (point), area, and volume [41]. The stack option was used in Task 1 to calculate ground-level concentrations due to stack emissions from the OHA facility. The area source equation in the ISCLT model is based on the equation for a continuous and finite line source and uses a virtual point source approximation. The volume source option is also used to simulate line sources such as the fugitive emissions from a roadway.

The conveyor transfer points and the truck loading operations occur within the boilerhouse (ash handling) building and were treated as volume sources in the ISCLT model. The ash handling building was treated as two volume sources with each volume having a side-length of 80 ft. by 80 ft. with a height of 40 ft.

The fugitive emissions due to the traveling trucks were assumed to occur along a road that follows a straight line between the ash handling building and the monofill area and were treated as volume sources. The fugitive emissions from the traveling trucks were represented by 20 volume sources, 70 ft. on each side with an emission height of 9.8 ft.

The fugitive emissions due to landfill activities, including the ash dumping, landfill maintenance, and wind erosion at the landfill, were treated as one area source that is 32 ft. (9.8 m) per side with an emission height of 3.3 ft. (1.0 m). The total fugitive emissions due to landfill activities at the monofill area was calculated to be 2.13×10^{-3} (2.13E-03) grams per second (g/sec) which was represented by a source strength of 2.2×10^{-5} grams per square meter-second ($\text{g}/\text{m}^2\text{-sec}$).

A total of 900 receptors in a 30 x 30 grid plus additional discrete receptors at sensitive locations were selected for use in the air quality modeling analysis. Spacing between receptors on the grid was set at 100 meters (m). The discrete receptors included one point at Spring Hill Farm and one point at Crystal Lake.

The ISCLT model uses statistical meteorological summaries in the form of joint frequency of occurrence tabulations. The joint frequency of occurrence of each of six wind speed classes with each of 16 wind direction sectors were tabulated for each stability class. For the air quality assessment for the fugitive ash emissions from the OHA facility, these climatological summaries were derived from hourly meteorological data derived from surface weather observations at Logan Airport in Boston, MA and upper air data collected at Portland, ME. In the initial air quality modeling analyses conducted in 1986 and 1987, meteorological data for the 1979-1983 (five year) period was used for the OHA assessment. During 1988 and 1989, additional air quality modeling analyses were conducted with meteorological data from the 1983-1987 (five year) period.

The ISCLT model was initially executed using the 1979-1983 meteorological data in the air quality concentration mode and the deposition mode to estimate the annual average air quality concentrations and deposition rates due to the ash handling activities at the OHA facility. To comply with the air quality modeling instructions contained in Information Request Set III-A, the ISCLT modeling runs were only used to calculate annual-average ground-level concentrations of particulates due to fugitive ash emissions.

As initially directed by the Board's consultants, the deposition rates were to be calculated using a constant deposition velocity of two centimeters per second (2 cm/sec). The 2 cm/sec deposition velocity is recommended by the California Air Resources Board (CARB) [25] for screening deposition analysis based on conservative assumptions regarding meteorology (2.5 m/sec wind speed, neutral stability and 25°C temperature) and an assumed particle density of 1 g/cm³, a surface roughness parameter of 1 meter (m), and a particle size of 10 microns (um).

Deposition rates were obtained from the annual average concentrations by use of the following equation:

$$F_d = (K) (V_d) (C_g) \quad (\text{g/m}^2 \text{ per year}) \quad (3-6)$$

where F_d = Annual deposition flux (g/m² per year)
K = 0.315 (conversion factor to change units)
 V_d = 2.0 cm/sec (assumed deposition velocity)
 C_g = Annual average ambient concentration (ug/m³)

While no ash particle size distribution was assumed in the analysis, the wind erosion analysis of the exposed ash surface assumed a modal particle size of 4 millimeter, or 4,000 um. The 2 cm/sec deposition velocity recommended by the CARB for screening analysis is based on an assumed particle size of 10 um. Based on the CARB document [25], a particle diameter of 70 um would have a deposition velocity of 15 cm/sec. Because the deposition rates, as shown in Equation (3-6), are directly proportional to the deposition velocity, the ash particle size distribution becomes an important component of the deposition rate analysis. While the 2 cm/sec value can be considered a conservative estimate of the deposition velocity for particulate stack emissions, the same cannot be said of the deposition velocity for the fugitive ash emissions for the OHA Landfill.

3.2.3 Screening-Level Health Risk Assessment

The Board requested that OHA prepare a conservative health risk assessment for the fugitive ash emissions for the OHA facility, encompassing all pathways of exposure. A screening level health risk assessment (HRA) for the ash handling activities at the OHA facility was prepared based on the

Board's instructions in September 1987 (OHA Responses to Information Request (IR) Set III-A). After reviewing the health risk assessment, the Board's technical consultants determined that the initial health risk assessment prepared by OHA failed to comply with the Board's instructions.

In response to the Board's technical consultants comments, OHA submitted a supplemental document, dated November 25, 1987, with revisions and corrections that resulted in a screening level excess lifetime cancer risk of one in a million. The Board's technical consultants reviewed the health risk assessment and reported in a document, submitted in January 1988, that several major errors were made in the OHA analysis.

After correcting for these errors, the Board's consultants estimated that the health risk due to ash handling activities would result in a screening level excess lifetime cancer risk of 190 in a million [26]. Based on the high excess cancer risk due to fugitive ash emissions, the Board's consultant recommended that OHA should submit to the Board an enforceable Ash Management Plan that would minimize the fugitive ash emissions from the OHA facility.

Instead of responding to the Board's comments and revising their screening risk assessment analysis, OHA submitted what it called a "refined" ash risk assessment. Using less conservative assumptions in the emission factor equations discussed in Section 3.2.1, lower emission rates were determined for the sources of fugitive ash emissions. The refined ash risk assessment conducted by OHA using the lower emission rates estimated that the lifetime cancer risk due to the ash handling activities was 0.008 in a million. In its refined ash risk assessment, OHA assumed that no fugitive ash is emitted from the storage building, no ash is emitted during transportation of ash to the landfill, and no ash is emitted during spreading, compacting, and covering.

The Record indicated that the primary reason for the divergent risk estimates calculated by OHA and the Board's consultants was the differences in the emission rates determined for the fugitive ash emissions. The Board's consultants felt that without actual monitoring data to substantiate their claims, the emission estimates in the screening level risk assessment were more reliable than the OHA re-fined estimate. OHA submitted two additional documents in support of their December 21, 1987 refined risk assessment. These documents described the differences between the methodology and assumptions used in the two risk assessments and estimated an excess lifetime cancer risk of approximately one in a million, even with the higher emission levels assumed in the screening level assessment.

Based on a review of the deliberations of the Board of Health on July 7, 1988, OHA proposed to modify its operation to ensure that air emissions from the OHA facility will not pose a threat for the public health, safety and the environment. OHA proposed in August 1988 [27] the following ash management procedures to minimize fugitive ash emissions from the OHA facility:

- (1) No Outside Conveyors. All systems for handling ash from its creation until its storage in the ash handling building will be conducted in a single enclosed building or with no outside conveying of ash until it is loaded into ash transport vehicles.
- (2) Negative Air Pressure. The ash storage building will be designed and configured so that it will be under negative air pressure and the doors of the building will be closed when ash is not being transported.
- (3) Ash Loading. To ensure that truck tires will not come into contact with the ash material, the truck loading area will be elevated so that any ash spilled will fall through the grates and not come into contact with truck tires. The floor of the ash storage building will be inclined so that ash will not accumulate on the working floor. In addition, OHA shall install such management techniques to ensure that the building floors are swept clean at the end of each day of truck loading and that trucks and tires leaving the ash building are free of ash.
- (4) Storage Building. During the time ash is being stored, the doors of the ash handling building will be closed.
- (5) Ash Transport Vehicles. All ash transport trucks used to transport ash at the landfill will be covered with tight-fitting metal covers and the truck beds shall be moisture tight. The trucks will not travel to or from the ash monofill without the covers in place to prevent any emission of ash during transport. OHA will prepare cover specifications and submit them to the Board.
- (6) Ash Landfilling. Ash will not be landfilled on a continual basis, but rather will be stored from the close of operations of the landfill in the evening. The ash will be loaded, transported, and landfilled in the early morning and late afternoon and will be covered daily.
- (7) Working Face. The ash monofill will be kept to as small a size as is practical. The working face will be arranged such that the transport vehicles will not, to the greatest extent possible, track over uncovered ash already deposited. The ash working face will be covered by a tarpaulin or similar material during those periods when the ash is not covered by daily cover or is not being worked or compacted.
- (8) Water Truck. A water truck with spray nozzle will be on-site at all times. The truck will be used to spray roadways to minimize ash dusting at the monofill and will be stationed at the working face where trucks are off loading.

- (9) Ash Sources. Only ash from OHA and the Lawrence facility ("OHA ash") or other Ogden facilities (if such ash does not pose any greater operational risk to public health or the environment than the OHA ash) shall be accepted for disposal at the Ward Hill Neck Landfill. [It should be noted that the air quality assessment of fugitive ash emissions at the OHA facility did not take into account the transport or dumping of ash from other OHA facilities. OHA estimated that four trucks per day are required to transport ash from the Ogden Lawrence facility.

As requested by the Board's counsel, Tech Environmental, Inc. reviewed [28] OHA's proposed modifications of operations and expressed opinions regarding the ash handling health risk and the adequacy of OHA's proposed program. Based on their review of the proposed ash handling program, the Board's consultant came to following conclusions:

- o The ash emissions during conveyance of ash and loading of trucks should be near zero with OHA proposing to convey and load ash into trucks within a single building maintained under negative air pressure.
- o In their proposed ash management plan, OHA agreed to use tight-fitting metal covers for the tops of the trucks, prevent the truck tires from becoming covered with ash in the ash handling building, and not drive over ash deposited at the monofill when arriving and departing. If the procedures are followed, the ash emissions from these activities should be zero. Ogden's consultant stated that these assumptions are only valid if the OHA employees strictly follow the proposed ash management plan and suggested that the Board post a health inspector at the monofill.
- o OHA estimated ash emissions of 0.13 lb/day when the trucks dump ash into the monofill for the screening risk assessment but only 0.007 lb/day (based on a higher assumed ash moisture content) for the refined risk assessment. The Board's consultants rejected the use of the lower emission rate because OHA offered no guarantee of the minimum moisture content for ash leaving the incinerator. Therefore, the Board's consultants stated that the ash emission rate due to this activity should remain at 0.13 lb/day (0.0054 lb/hr).
- o In estimating the ash emissions due to wind erosion and mechanical disturbances of the ash by a bulldozer, OHA estimated total ash emissions for the screening risk assessment to be 0.28 lb/day while the refined analysis assumed zero emissions. The Board's consultants disagreed with the assumptions used by OHA in their refined analysis and stated it was not possible to revise the emission estimate except to say that it would be greater than zero but less than 0.30 lb/day.

Based on the ash management plans proposed by OHA in their August 1988 memorandum, the Board's consultant concluded that the "best estimate" of the total fugitive emissions at the monofill would range from 0.13 to 0.43 pounds per day (lb/day).

Using this range of ash emissions, Tech Environmental, Inc. (the Board's consultant) revised their screening health risk estimate of 190 in a million (reported to the Board earlier) to somewhere between 30 and 100 in a million. If OHA would agree to guarantee that all ash leaving the facility in covered trucks have a minimum moisture content of 20 percent, the Board's consultants stated the screening health risks would lie in the range of 17 to 83 in a million.

As stated in their testimony before the Board and in their August 25, 1988 letter [28], the Board's consultants felt that any refined risk assessment should be based on use of actual or demonstrably representative emission data. Without actual data, the Board's consultants stated that no refined health risk assessment was warranted.

While OHA did not agree that a health risk assessment should be restricted to a screening and, therefore, more conservative analysis due to the lack of fugitive ash emission data, OHA prepared a supplemental screening analysis which was submitted to the Board on December 6, 1988 [29]. Conducting a screening-level health risk assessment in accordance with the instructions provided in Information Request Set III-A and as modified by the Board's consultants, OHA calculated a maximum excess lifetime cancer risk of 3.5 in a million. This risk was based on the total fugitive ash emissions from the ash handling activities at the OHA facility including ash emissions from the ash handling building and ash transport vehicles. This analysis did not include any ash received from another OHA facility.

This risk was based on the maximum annual average concentration and deposition rate as reported in the Sigma Research Corporation report [33]. The air quality analysis used five years (1983-1987) of meteorological data collected at Logan Airport and over 900 receptors, including discrete receptors at Spring Hill Farm and Crystal Lake.

While OHA did not agree with some of the worst-case assumptions used in its initial November 1987 ash risk assessment, key revisions included in the December 6, 1988 [29] analysis included the following conservative changes:

- o Recalculation of air quality concentrations and deposition rates;
- o Duration of inhalation exposure - 70 years;
- o Duration of deposition accumulation - 70 years;
- o Adjustments to the soil/fly ash ingestion absorption coefficients for lead, chromium, and PCBs;
- o Adjustments to the bioconcentration factors in fish for lead, chromium, calcium, and 2,3,7,8-TCDD equivalents;
- o Expansion of the maternal milk exposure pathway to include additional organic carcinogens;
- o Expansion of the fish ingestion (leachate) pathway to include arsenic;
- o Addition of an exposure pathway for ingestion of drinking water from Crystal Lake;
- o Correction of soil concentrations and deposition concentrations for use of appropriate receptors.

The OHA December 6, 1988 analysis [29] caculated a total lifetime cancer risk of 3.5 in a million at the maximum impact location. Table 3-9 summarizes the total potential carcinogenic risks by various exposure pathways as calculated by OHA. In addition, Table 3-9 provides a summary of the potential risks by pollutants. The total potential lifetime cancer risk was calculated based on the fugitive ash emission sources as described in Section 3.2.1 and included fugitive emissions from the ash handling building and the ash loading, transport, and dumping at the OHA facility. As evident in the total potential risk summaries, the ingestion of vegetables grown at the point of maximum impact accounts for over 97 percent of the total potential risk due to all pollutant (ash) emissions. The potential risk due to only arsenic emissions from the ingestion of vegetables grown at the point of maximum impact accounts for approximately 96 percent of the total potential risk.

3.2.4 Additional Air Quality and Health Risk Assessments

In order to evaluate the differences between the health risk assessments presented by OHA and the Board's consultants, the Task Force met with both technical consulting groups and reviewed the extensive information provided in the Hearing Record. In addition, the Task Force requested that OHA conduct additional air quality modeling analysis for ash emissions from the OHA facility incorporating the conditions imposed by the proposed ash management plan and expanding the analysis to include the northern most point in the Landfill area where ash can be deposited.

A meeting was held with OHA and its technical consultants to discuss the health risk assessment studies conducted for fugitive ash emissions from the OHA Landfill. At a meeting on February 23, 1989, Envirologic Data presented an additional health risk assessment that attempted to identify and correct errors in the original Tech Environmental, Inc.'s estimated risk of 190 in a million. Using correction factors for each pathway using the correct soil concentration and applying the Tech Environmental, Inc.'s time factor to adjust the deposition concentrations, a "corrected" estimate of total risk based on the original screening-level health risk assumptions was determined by Envirologic Data.

Table 3-10 compares the total potential excess lifetime risks of 190 in a million as calculated by Tech Environmental (Column A) and the "corrected" total potential risk of 9 in a million as calculated by Envirologic Data (Column B). It should be noted that the Envirologic Data risk calculation starts with the 190 in a million total risk and recalculates each pathway based upon the appropriate correction factors. It should also be noted that OHA's analysis continued to (conservatively) assume that ash emissions from the ash handling building and ash transport vehicles were not zero even though the Board's consultants stated that they would be negligible if OHA followed the proposed ash management procedures (see Section 3.2.3).

As shown in Table 3-10 (Column A), the total potential excess cancer risk was determined to be due mainly to emissions of 2,3,7,8 TCDD toxic equivalents from the ash handling activities at the OHA facility. As will be shown later, this is not the case and arsenic emissions as shown in Table 3-10 (Column B) are responsible for the majority of the total potential risk calculation.

TABLE 3-9

SUMMARY OF TOTAL POTENTIAL EXCESS LIFETIME CARCINOGENIC RISKS
DUE TO FUGITIVE ASH EMISSIONS

<u>By Exposure Pathway</u>	<u>Total Potential Lifetime Cancer Risks in a Million</u>
Inhalation	< 0.10
Ingestion of Soil	< 0.01
Ingestion of Fish	< 0.01
Ingestion of Beef	< 0.01
Ingestion of Milk	< 0.01
Ingestion of Vegetables	3.4
Ingestion of Maternal Milk	< 0.10
Dermal (Contact with Soil)	< 0.10
Ingestion of Surface Water	< 0.01
Total Potential Risk (Number in a Million)	3.5

<u>By Pollutant of Concern</u>	<u>Total Potential Lifetime Cancer Risks in a Million</u>
Arsenic	3.4
Cadmium	< 0.10
Chromium	< 0.01
Nickel	< 0.01
Polychlorinated Biphenyls (PCBs)	< 0.01
2378-TCDD Equivalents	< 0.01
Benzo(a)pyrene	< 0.01
Hexachlorobenzene	< 0.01
Chlorinated Phenols	< 0.01
Total Potential Risk (Number in a Million)	3.5

TABLE 3-10

COMPARISON OF TOTAL POTENTIAL EXCESS LIFETIME CARCINOGENIC RISKS
BY POLLUTANTS OF CONCERN

COLUMNS	[A]	[B]
<u>Exposure Pathway</u>	<u>Board's Consultants Total Risk Calculations</u>	<u>OHA's Consultant Total Risk Calculation</u>
Arsenic	23	9
Cadmium	< 0.10	< 0.10
Chromium	< 0.01	< 0.01
Nickel	< 0.01	< 0.01
Polychlorinated Biphenyls	< 0.01	< 0.01
2378-TCDD Equivalents	161	< 1
Benzo(a)pyrene	5	< 0.10
Hexachlorobenzene	< 1	< 0.01
Chlorophenol	< 0.10	< 0.01
Total Potential Lifetime Cancer Risks in a Million	190	9

After an earlier review of the health risk assessment conducted by the Board's consultants (which estimated a risk of 190 in a million), Envirologic Data wrote a letter [32] on December 6, 1988 to OHA's attorneys indicating that an error was made by the Board's consultants in attempting to correct existing errors made by OHA and its consultants in their initial health risk assessment. After reviewing this finding, the Board's consultant (Tech Environmental, Inc.) did not agree with all of the statements made in the letter but did agree on several key issues. As stated in a letter to the Board's attorneys [30] in December 1988, Tech Environmental, Inc. recalculated the risk to be 22 in a million instead of their initial risk estimate of 190 in a million.

The cancer risk estimate of 190 in a million due to fugitive ash emissions has been a major concern to the Board in its evaluation of the total health risks due to the operation of the OHA facility. A great deal of technical information has been prepared for the Record over the past two year on this estimated health risk number. This agreement between the two technical consulting groups resulted in a major reduction of the upper level risk due to ash handling operations at the OHA facility. The Task Force's work scope did not include conducting a revised health risk assessment. However, the Task Force hoped that by working with the technical consultants, a closer agreement could be made between the health risk estimates made by each consulting group.

At a meeting with the Board's consultants [Mr. Peter H. Guldberg (Tech Environmental, Inc.) and Dr. Alan Eschenroeder (Alanova, Inc.)] on March 16, 1989, the Task Force discussed the ash risk assessment studies conducted for the OHA facility and presented additional work performed by Ogden's consultants (as discussed below) that had not been made available to the Board's consultants. After reviewing the new material and obtaining a copy of the December 6, 1988 Supplemental Submittal [29], Mr. Peter H. Guldberg (Tech Environmental, Inc.) stated that he agreed with Envirologic Data's new total risk number of 9 in a million. In addition, with the improvements in the ash management plan proposed by OHA, Mr. Guldberg estimated that the total excess lifetime cancer risks due to fugitive ash emissions should be reduced to a range from one to five in a million [31].

At the meeting held with OHA and its technical consultants on February 23, 1989, the Task Force requested that OHA remodel the fugitive ash emissions from the OHA facility using the ash emission rates determined for the ash handling activities at the monofill area but not including any sources due to the ash handling building or ash transport vehicle activities. In addition, the Task Force requested that fugitive emissions from the ash monofill source be modeled at two locations. Besides the original location used in all of the previous analyses, the Task Force requested that the monofill area source be modeled at the northern most point in the Landfill where ash can be deposited.

Sigma Research Corporation prepared a report [33] dated December 16, 1988 that summarized the air quality modeling results when all of the potential fugitive emissions identified in IR Set III-A were modeled. Based on the results from this analysis, OHA prepared a supplemental submittal to the

Board [29] that stated the maximum risk due to fugitive ash emissions at the OHA facility would be less than 3.5 in a million. As stated before, this analysis included fugitive ash emissions from the ash handling building and the ash transport vehicles.

Based on the request received from the Task Force, Sigma Research Corporation remodeled the potential ash emissions from the OHA facility using the ISCLT model and the same modeling assumptions that were used in the previous analysis [33]. Surface meteorological data collected at Logan Airport for the 1983-1987 five-year period was used. A total of 690 receptors were used in addition to several discrete receptors. Spacing between receptors in the 30 x 23 grid was 100 meters (m). Terrain elevations were determined for each receptor. The discrete receptors included one point at Spring Hill Farm and one point at Crystal Lake.

Estimates of the emissions from the monofill activities were set at 0.43 lb/day as requested by the Task Force. This emission rate was the upper limit (most conservative) of the "best estimate" of the total fugitive ash emissions at the monofill as made by the Board's consultants [28] after reviewing the ash management plans proposed by OHA. The Task Force told OHA that they could use the lower emission rate if OHA would guarantee the minimum moisture content for ash leaving the incinerator was 20 percent.

Emissions from the monofill were modeled as one area source that is 9.8 m by 9.8 m per side. Because the monofill source could be located anywhere within the Landfill designed to receive the ash, the monofill emissions were modeled at two locations which represent positions near the northern and southern (initial location) boundaries of the Landfill site which may be designated as an approved monofill area. The position of the "South Location" is identical to the location used in the IR Set III-A modeling analysis. The position denoted as the "North Location" was place just inside the northernmost point along the 140 ft. height contour as shown in the preliminary ash monofill contour maps (see Figure 3-1).

As shown in Figure 3-1, the maximum annual average concentration due to emissions at the South Location of the monofill were calculated to occur across the Merrimack River to the west, rather than across Route I-495 to the east as was found when all of the sources identified in IR Set III-A were modeled. For the five-year meteorological record (1983-1987) used in the analysis, the maximum annual average concentration was predicted to occur using the 1983 meteorological data. The maximum annual average concentration due to emissions at the North Location of the monofill were calculated to occur in 1985 at a location directly across the Merrimack River to the northeast of the source.

Deposition rates were obtained by multiplying the calculated ambient air quality concentration at each receptor by an assumed deposition velocity of 2 cm/sec (see Equation 3-6). Annual deposition due to each of the monofill locations were presented on contour maps in units of grams per square meter per year ($\text{g/m}^2\text{-year}$) for each of the five years that were modeled.

- | | |
|--|--|
| 1 South Monofill Area | 3 North Monofill Area |
| 2 Maximum Impact due to South Monofill Ash Emissions | 4 Maximum Impact due to North Monofill Ash Emissions |
| ⊕ OHA Boiler Building | |

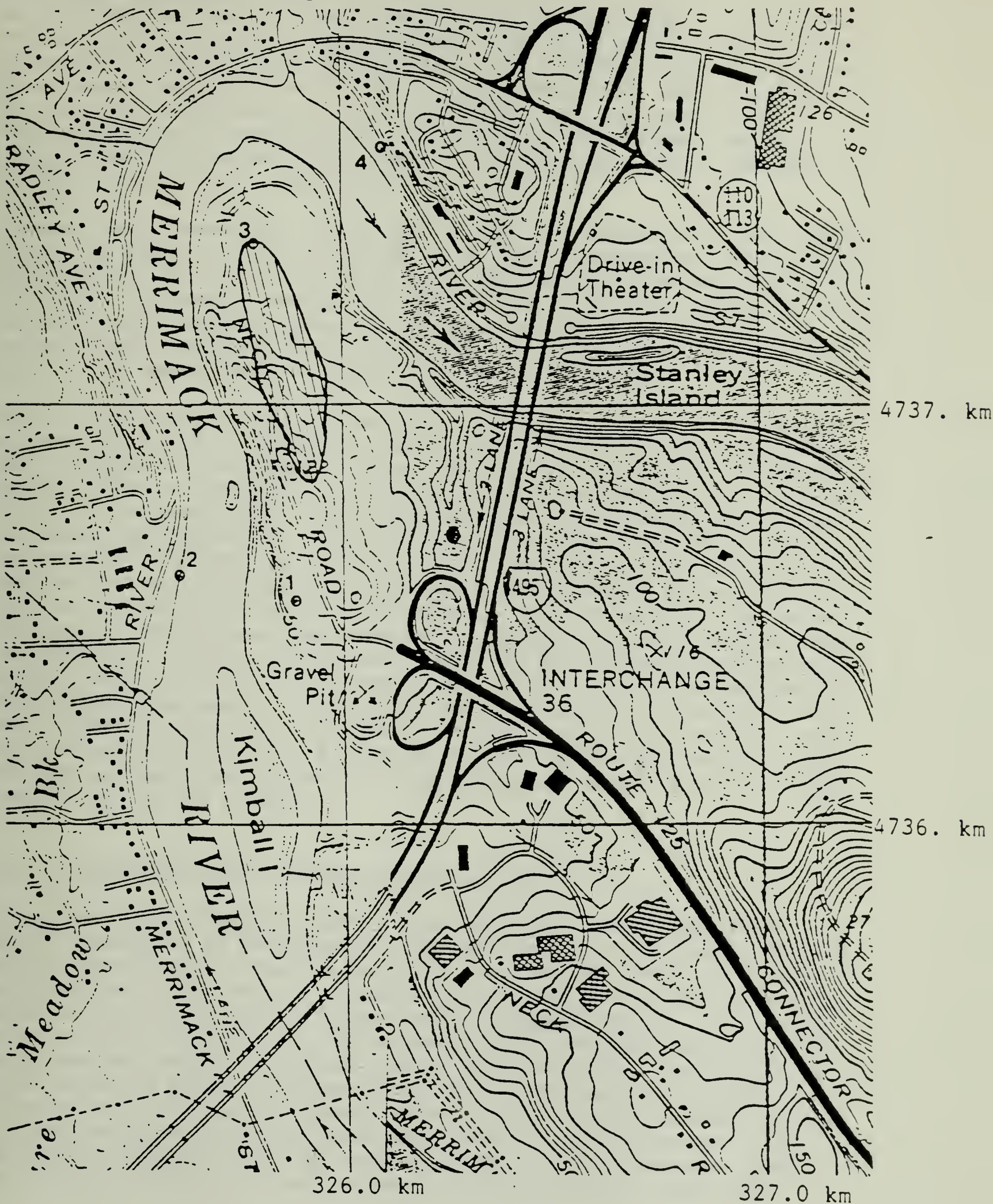


Figure 3-1 Location of OHA Ash Monofill Areas

The maximum deposition values that were obtained from the ISCLT model analysis when all fugitive ash emission sources identified in Information Request (IR) Set III-A are compared with those obtained when the fugitive ash emissions only occur at the monofill site in Table 3-11. The maximum annual deposition value due to all ash emission sources identified in IR Set III-A was calculated to 0.0105 (1.05E-02) g/m² per year. This deposition value is more than two times greater than the maximum annual average deposition value due to fugitive ash emissions at the southern or northern monofill site location.

A comparison of deposition values due to only ash emissions at the monofill source are shown in Table 3-11 to be less than the deposition values calculated for all IR Set III-A sources at the Spring Hill Farm and Crystal Lake locations. The annual average air quality concentrations calculated using the ISCLT model and the deposition values shown in Table 3-11 at the maximum impact location, Spring Hill Farm, and Crystal Lake are used in the fugitive ash health risk assessment for the OHA facility.

All previous health risk assessments were determined based on the fugitive ash emission rates as established by IR Set III-A and included ash emissions from the ash handling building, ash transport vehicles, and monofill source. Based on the meeting held with OHA and its consultants on February 23, 1989, Envirologic Data submitted a technical memorandum [34] to the Task Force that presented a revised health risk assessment that calculated the potential risk for the two hypothetical locations of the monofill. Based on the maximum deposition from the monofill source for each site (as presented in the Sigma report) and using the same assumptions that were followed in the previous risk assessments, Envirologic Data recalculated the total risk for each pathway and summed for all pathways for the two monofill site locations. As shown in Table 3-12, there is no appreciable difference in the health risks associated with either location with the total potential risk for all pathways between 1 and 2 in a million. This total potential risk estimate compares with Mr. Guldberg's estimate [30] that the screening level risk due to fugitive ash emissions should range from one to five in a million.

3.2.5 Findings of Task 2 Review and Evaluation

In response to the Board's request in IR Set III-A, OHA submitted an air quality assessment of the potential fugitive ash emissions due to the ash handling activities at the OHA facility. The initial health risk assessment prepared by OHA was not conducted in accordance with the instructions given in IR Set III-A and contained some additional errors. OHA submitted revisions and corrections to the screening level analysis and later prepared what was called a "refined" health risk assessment that estimated the health risk due fugitive ash emissions to be less than one in a million. In response to the Board's concern about using a refined analysis without any real empirical emissions data, OHA resubmitted the screening level analysis in December 1988 [29] correcting the earlier errors and following the IR Set III-A instructions as modified by the Board's consultants.

TABLE 3-11

COMPARISON OF FUGITIVE ASH PEAK DEPOSITION RATES
DUE TO MONOFILL SOURCE AND ALL SET III-A SOURCES

Receptor	Annual Fugitive Ash Deposition ($\text{g}/\text{m}^2\text{-year}$)		
	<u>Southern Monofill Source</u>	<u>Northern Monofill Source</u>	<u>All IR Set III-A Sources (**)</u>
Maximum Impact ($\text{g}/\text{m}^2\text{-year}$)	3.65E-03	4.41E-03	10.50E-03
Location: (*)			
- Distance (miles)	0.2	0.2	0.3
- Direction (degrees)	280	53	96
- Meteorological Year	1983	1985	1985
Spring Hill Farm ($\text{g}/\text{m}^2\text{-year}$)	3.30E-04	1.34E-04	6.00E-04
Location: (*)			
- Distance (miles)	0.9	1.4	0.9
- Direction (degrees)	144	155	144
- Meteorological Year	1985	1985	1985
Crystal Lake ($\text{g}/\text{m}^2\text{-year}$)	2.80E-05	3.70E-05	3.90E-05
Location: (*)			
- Distance (miles)	2.6	2.1	2.6
- Direction (degrees)	341	338	341
- Meteorological Year	1984	1984	1985

(*) Receptor location for southern monofill source and all IR Set III-A sources based on distance (miles) and direction (degrees) from southern monofill location. Receptor location for northern monofill source based on distance (miles) and direction (degrees) from northern monofill location.

(**) All IR Set III-A sources include ash emissions from ash handling building, ash transport vehicles, and monofill source at southern location. The emission rate of ash from the south monofill source was equal to 0.169 pounds per day (lb/day) of this modeling. The new modeling of the monofill source alone uses an emission rate of 0.43 lb/day for the southern and northern location.

Note: Exponential format used - e.g., 3.70E-03 is equal to 3.70×10^{-3} is equal to 0.0037.

TABLE 3-12

SUMMARY OF TOTAL POTENTIAL EXCESS LIFETIME CARCINOGENIC RISKS
BY VARIOUS EXPOSURE PATHWAYS

<u>Exposure Pathway</u>	<u>Total Potential Lifetime Cancer(*)</u> <u>Risks in a Million</u>	
	<u>Southern Location</u>	<u>Northern Location</u>
Inhalation	< 0.10	< 0.10
Ingestion of Soil	< 0.01	< 0.01
Ingestion of Fish	< 0.01	< 0.01
Ingestion of Beef	< 0.01	< 0.01
Ingestion of Milk	< 0.01	< 0.01
Ingestion of Vegetables	1.4	1.6
Ingestion of Maternal Milk	< 0.10	< 0.10
Dermal (Contact with Soil)	< 0.10	< 0.10
Ingestion of Surface Water	< 0.01	< 0.01
Total Potential Risk (Number in a Million)	1.4	1.7
(*) Ash Monofill Location (See Figure 3-1)		
UTM Coordinates:		
(x - meters)	325880	325795
(y - meters)	4736550	4737370
Maximum Impact Location		
UTM Coordinates:		
(x - meters)	325600	326100
(y - meters)	4736600	4737600
Maximum Impact Location (relative to Ash Monofill Location)		
- Distance (miles)	0.2	0.3
- Direction (degrees)	280	53
Emission Height (m)	1.0	1.0
Base Elevation (m)	47.2	47.2
Width of Monofill Area (m)	9.8	9.8
Source Strength (g/m ² -sec)	2.35E-05	2.35E-05

Based on this analysis, OHA estimated that the potential lifetime cancer risk due to fugitive ash emissions at the point of maximum impact was 3.5 in a million (see Table 3-9). The Board's consultants recommended that the potential lifetime cancer risk due to ash handling activities would result in a screening level risk of 190 in a million [26] (see Table 3-10).

On December 13, 1988, the Board, OHA and Refuse Fuels Associates (RFA) signed a Modification of Site Assignment by Stipulation (hereinafter "Stipulation of Conditions") [24]. This agreement constitutes an amendment to the Site Assignment with the Board reserving the right to suspend or modify the Site Assignment as such rights exist under the laws of the Commonwealth of Massachusetts. As discussed in Section 3.2.3, OHA agreed to modify its ash management procedures to minimize fugitive ash emissions from the OHA facility. As stated in the Stipulation of Conditions, all ash handling and disposal activities at the OHA facility shall conform to the following procedures:

- (1) Ash Handling Building. All systems for handling ash in preparation for transport to the Landfill will be conducted in a single enclosed building, or with the use of enclosed conveyors between buildings. The ash handling building will be designed and configured so that it will be under negative air pressure and the doors of the building will be closed when ash is not being transported. The truck loading area will be elevated so that any ash spilled will not come into contact with truck tires and the floors will be swept clean at the end of each day.
- (2) Ash Transport Vehicles. All ash transport vehicles disposing of ash at the Landfill, regardless of origin, will be covered with tight fitting covers and the truck beds shall be moisture tight.
- (3) Ash Landfill Area. Ash will be loaded, transported and landfilled in the early morning and late afternoon and will be covered daily. The working face will be kept to as small a size as is practicable and situated such that transport vehicles will not, to the greatest extent possible, track over uncovered ash. A water truck will be on site at all times to spray roadways to minimize landfill dusting and to prevent ash dusting at the monofill during ash landfilling and covering operations.
- (4) Ash Moisture Content. Ash in the storage building, transport vehicles, and during landfilling shall be maintained at a moisture content at approximately 20 percent or a level sufficient to minimize ash dusting. Moisture samples shall be taken at the working face and analyzed weekly during the period from June 1 and September 1, and monthly during all other periods.
- (5) Ash Sources. Only ash from OHA and the Ogden-Lawrence facility ("OHA ash") or other Ogden facilities (if such ash does not pose any greater operational or long-term risk to the public health or the environment than OHA ash) shall be accepted for disposal at the Ward Hill Neck Landfill.

With the Board's decision that the total potential lifetime cancer risks due to all pollutant emissions from the OHA facility should be less than 10 in a million, the upper level risk estimate of 190 in a million due to only fugitive ash emissions has been a major concern to the Board. In December 1988, after reviewing comments received from the OHA consultants, the Board's consultants recalculated the risk to be 22 in a million instead of their initial risk estimate of 190 in a million [30].

After meeting with the Task Force in March 1989 and reviewing additional information that had not been provided to them, the Board's consultants lowered its ash risk estimate to 9 in a million. In addition, the Board's consultants estimated that the screening level risk due to fugitive ash emissions should reduce to a range from one to five in a million if OHA follows the ash management procedures stated in the Stipulation of Conditions. Based on the Task Force's review of the technical information included in the Record and discussions with all involved consulting groups, it appears that both parties agree that the total excess lifetime cancer risks due to fugitive ash emissions at the monofill should reduce to a range from one to five in a million. If adjustments are made for the reduced arsenic potency now approved by U.S. EPA, the total lifetime risk due to fugitive ash emissions should be less than one in a million.

The Task Force requested that OHA remodel the fugitive ash emissions from the OHA facility based on the ash emission rates determined for the ash handling activities at the monofill area. In addition, the Task Force requested that the fugitive ash emissions from the monofill be modeled at two locations (North and South) representing the opposite ends of the Landfill area. The ISCLT model was used to calculate the maximum annual average concentrations using the same modeling assumptions that were used in the previous air quality analyses and the hourly meteorological data collected at Logan Airport over a five-year (1983-1987) period. Annual deposition values were obtained by multiplying the ambient annual-averaged concentrations at each receptor by an assumed deposition velocity of 2 cm/sec.

The maximum annual average concentrations due to ash emissions at the South (original) Location of the monofill were calculated to occur across the Merrimack River (approximately 0.2 miles) to the west of the Southern monofill area (see Figure 3-1). In the original air quality analyses of fugitive ash emissions due to the ash handling operations at the OHA facility, which included ash emissions from the ash handling building and trucks enroute to the monofill area, the maximum annual-average concentrations due to fugitive ash emissions was calculated to occur across Route I-495 to the east of the OHA facility.

The maximum annual-average concentration due to ash emissions at the North Location of the monofill were calculated to occur directly across the Merrimack River (approximately 0.3 miles) to the northeast of the monofill area (see Figure 3-1). The maximum annual-average concentration due to fugitive ash emissions at the northern monofill location was approximately 20 percent higher than the maximum annual-average concentration when the same fugitive emissions are located at the southern monofill location. However, the maximum annual-average concentration due to ash emissions at the northern monofill location is more than 50 percent lower than the maximum concentrations used in the stack health risk assessment.

3.3 TASK 3: Evaluation of Appropriateness of Logan Airport Meteorological Data

3.3.1 Geographical Relationships and Settings

Lawrence Municipal Airport is the closest site to the OHA facility that has collected sufficient meteorological data to allow a comparative analysis. This analysis is complex since it must first examine whether meteorological conditions at Logan Airport are reasonably representative of conditions at Lawrence Airport, and then estimate the micro-meteorological relationship between Lawrence Airport and the OHA plant site.

There are differences in the geographical settings of the OHA facility and the Lawrence Airport. Because of these differences, and the fact that the Lawrence database comprises less than one-half of all possible data hours in 1983, professional judgement is called for in assessing whether using five years of meteorological data from Logan Airport is an appropriate way to project air quality impacts from the OHA facility.

The Lawrence Airport is situated on a plateau on the east bank of the Merrimack River at an approximate elevation of 95 feet (Mean Sea Level - MSL); about 85 feet above river level. At this location, the river runs in a general north-northeasterly direction. Terrain which could affect meteorological conditions at the airport lies to the southeast and east, with elevations ranging from 150-200 feet above the level of the airport. The terrain peaks are at a distance of approximately 1.5 to 2.0 kilometers (km) [0.9 to 1.2 miles]. Terrain from the northwest through south is more gently rolling, with the high elevations at a greater distance than those to the east.

The local drainage flow, which is a low-level stable flow in the Merrimack River valley, may not be felt at the Lawrence Airport, judging from the location of the wind sensor with respect to the river. This cannot be proven however, because during late night and early morning hours when these conditions would occur, no observations were recorded.

Logan Airport is situated on the western edge of Boston harbor. Winds observed at this location would be unaffected by major terrain features. Due to the openness of the location, wind speeds would be expected to be higher than those observed at a more protected site. A major feature that is expected to be present in the Logan Airport data base is the influence of the easterly sea breeze, which is a common occurrence in the warm months.

The OHA facility is located at the approximate center of a meander in the course of the Merrimack River, where the river changes direction from an approximate northerly route around Ward Hill Neck, on to the southeast.

The facility is located on the east bank at an elevation of approximately 30 feet MSL; 20 feet above river level. This location is 5.4 km (3.4 miles) from the Lawrence Airport, in a direction slightly east of north, and 54.7 km (34.0 miles) from Logan Airport.

At the OHA site, some major terrain features lie to the northeast through southeast, as is the case with the Lawrence Airport. Unlike the Lawrence Airport, there are nearby terrain features on the west bank of the river, with one peak rising to an elevation of 270 feet above the plant's base elevation at a distance of 1.7 km (1.1 miles).

At this location, low-level ash emissions could be influenced by local meteorological conditions in the Merrimack River valley. The transport and dispersal of stack emissions, on the other hand, are not likely to be significantly affected by these local conditions.

3.3.2 Extent of Data Base

The original modeling done for the OHA permit application used hourly meteorological data for the years 1979 through 1983. For this data comparison, 1983 was the year selected since it is the period containing the greatest amount of data for the Lawrence Airport. These were the reasons that OHA's consultants had selected 1983 for a prior evaluation.

In 1983, Lawrence Airport reported the following hourly observations of wind speed and direction:

<u>Hour</u>		<u>Hour</u>	
Jan. - 5 days/week,	0900-1700	Jul. - 7 days/week,	0800-1800
Feb. - 5 "	, 0900-1700	Aug. - 7 "	, 0800-2100
Mar. - 5 "	, 0900-1700	Sep. - 7 "	, 0800-2200
Apr. - 5 "	, 0900-1700	Oct. - 7 "	, 0800-2200
May - 7 "	, 0800-1800	Nov. - 7 "	, 0800-2200
Jun. - 7 "	, 0800-1800	Dec. - 7 "	, 0800-2200

In constructing the data bases for purposes of comparison, the Logan Airport data were screened and hourly data values discarded where there was not a concurrent data value in the Lawrence Airport data base. This analysis produced 4,001 (hourly) data points.

3.3.3 Data Comparisons

Hourly data recorded at airports are instantaneous observations typically made at fifteen minutes before the hour. In this sense, they do not represent true hourly averages, as would be the case with an on-site meteorological monitoring program where the data are electronically averaged over the hour. However, since the data recorded at the Logan and Lawrence airports were similarly obtained, there is basis for comparison.

Wind roses for all data points in 1983 for Logan and Lawrence airports are shown in Figures 3-2 and 3-3. Listings of the data summaries used in constructing the wind roses appear in Tables 3-13 and 3-14.

The patterns appear similar. With regard to wind direction, Logan Airport data exhibit distinct "spikes" at the east and west, whereas the predominant wind at Lawrence Airport was from the west-southwest. It is noteworthy that in the Logan Airport frequency distribution, wind speed occurrences are fairly evenly scattered throughout the distribution, whereas for the Lawrence Airport, they are weighted toward the middle of the distribution. In other words, at Lawrence there were relatively fewer occurrences of winds from 1-3 knots, and fewer in excess of 17 knots.

Fewer data points at the high end of the distribution implies that wind speeds at Lawrence do not attain speeds as high as those at Logan Airport. The deficiency at the low end of the distribution could be partially due to a higher occurrence of low wind speeds at the OHA facility than at Logan Airport. This would be a result of the openness of the Logan site. For nighttime hours, where there are no data for comparison, this cannot be assumed.

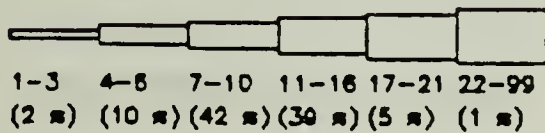
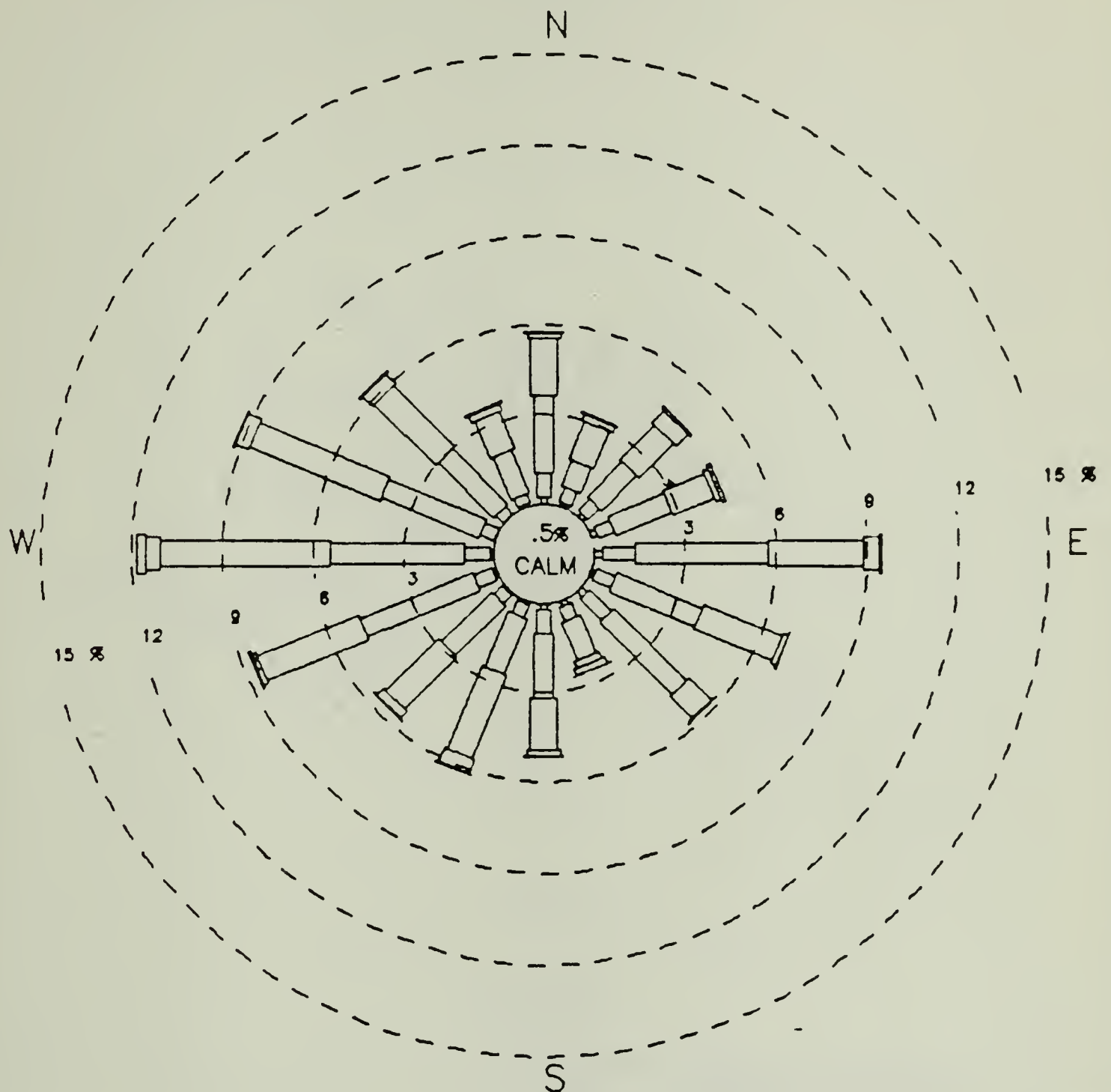
Another possible cause could be related to instrument performance. Older wind sensors such as the Bendix Aerovane type (which was used at Lawrence) were generally characterized as having high "starting speeds". The starting speed is the wind speed required to overcome friction and start the sensor spinning from a stopped position. To illustrate, if an instrument had a starting speed of 2.5 knots, a 2 knot wind would not be registered and would be recorded as a calm, while a more sensitive instrument (with a starting threshold less than 2 knots) at the same location would register 2 knots.

With age and insufficient bearing maintenance, this condition would tend to worsen.

Next, the average wind speed for each wind direction sector was calculated. It should be noted that only non-zero speeds were used in this calculation, thereby minimizing any bias from one instrument having a higher starting speed than another. These results are shown on Table 3-15, where it will be noted that the overall average wind speed at Logan Airport is almost 25 percent higher than at the Lawrence Airport. In addition, in each case the average sector-by-sector wind speed is higher at Logan Airport.

Finally, wind characteristics were examined as a function of Pasquill-Gifford stability class. As shown in Table 3-16, the comparative data base included almost all of the hours in 1983 that were indicated by Logan Airport data as being in the stability classes "A" through "C". For the remaining stability classes ("D" through "F"), much data is not present in the comparative data base. This is because nighttime observations were not made at Lawrence Airport.

FREQUENCY OF WIND DIRECTION & SPEED



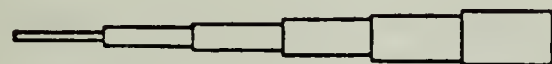
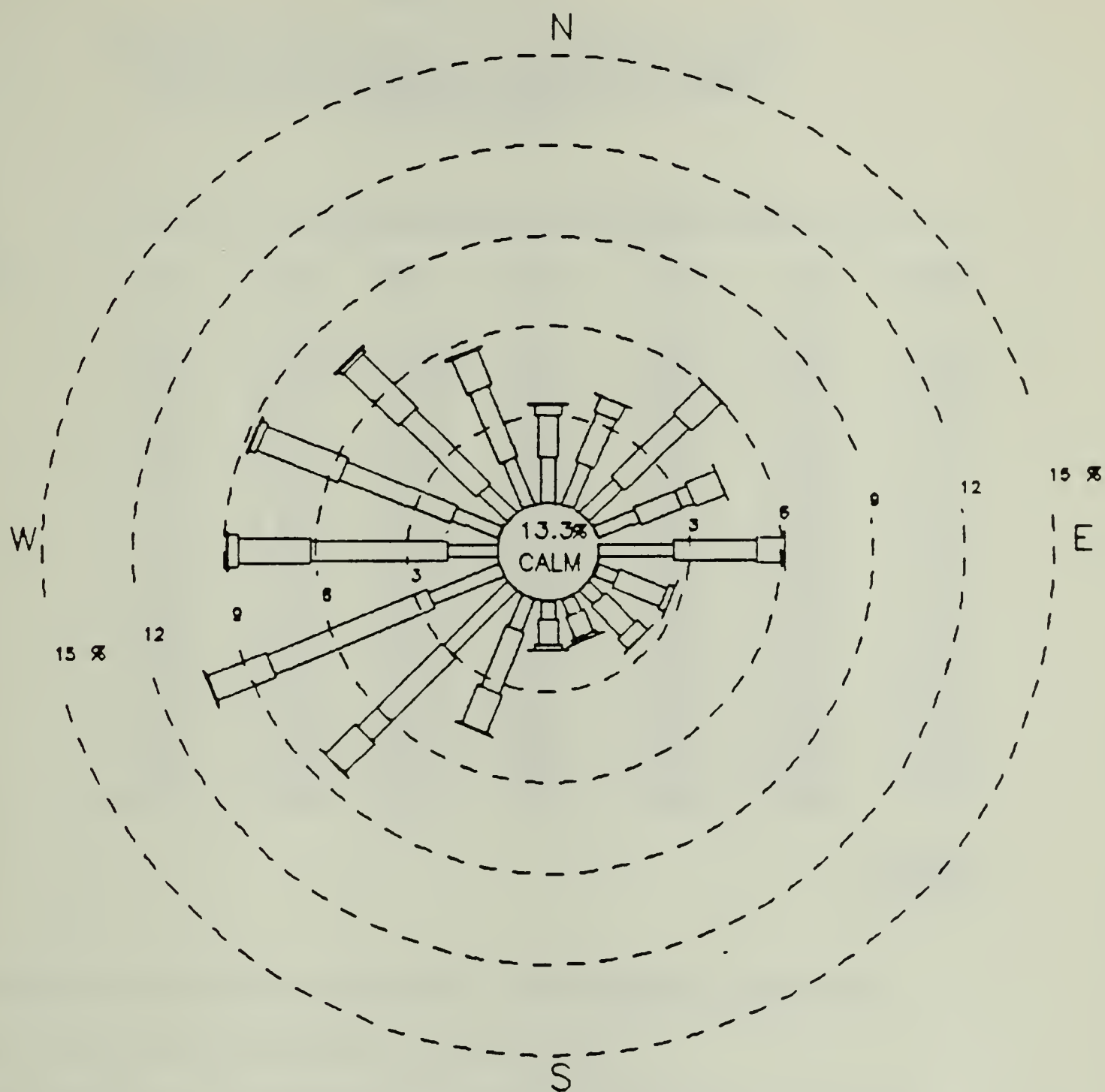
WIND SPEED SCALE (KNOTS)

NOTE - WIND DIRECTION IS THE DIRECTION WIND IS BLOWING FROM

Ogden Haverhill

Figure 3-2
Logan Airport
Sfc Data; Daytime Hrs
- Annual -
Data Year 1983

FREQUENCY OF WIND DIRECTION & SPEED



1-3 4-6 7-10 11-16 17-21 22-99
(0 %) (24 %) (42 %) (18 %) (1 %) (0 %)

WIND SPEED SCALE (KNOTS)

NOTE - WIND DIRECTION IS THE
DIRECTION WIND IS BLOWING FROM

Ogden Haverhill

Figure 3-3

Lawrence Airport

Sfc Data; Daytime Hrs

- Annual -

Data Year 1983

TABLE 3-13

FREQUENCY DISTRIBUTION (%) OF WIND DIRECTION
AND SPEED FOR LAWRENCE MUNICIPAL AIRPORT
- 1983 DATA YEAR -

Wind [*] Direction	Wind Speed Class (Knots) [**]						Total
	<u>1-3</u>	<u>4-6</u>	<u>7-10</u>	<u>11-16</u>	<u>17-21</u>	<u>≥ 22</u>	
N	0.000	1.625	1.300	0.400	0.050	0.000	3.374
NNE	0.000	1.550	1.800	0.575	0.000	0.000	3.924
NE	0.000	1.625	2.924	1.425	0.050	0.000	6.023
ENE	0.025	1.475	1.875	1.125	0.000	0.000	4.499
E	0.000	2.474	2.699	0.950	0.000	0.000	6.123
ESE	0.050	0.700	1.675	0.250	0.000	0.000	2.674
SE	0.000	0.675	1.350	0.475	0.025	0.000	2.524
SSE	0.025	0.575	0.775	0.175	0.000	0.000	1.550
S	0.025	0.625	0.775	0.225	0.000	0.000	1.650
SSW	0.000	1.175	2.124	1.375	0.050	0.000	4.724
SW	0.000	3.024	3.824	1.425	0.050	0.000	8.323
WSW	0.000	2.524	5.574	2.149	0.075	0.025	10.347
W	0.000	1.675	4.449	2.299	0.400	0.075	8.898
WNW	0.025	1.675	3.874	2.824	0.325	0.075	8.798
NW	0.000	1.350	3.474	2.524	0.225	0.075	7.648
NNW	0.000	1.750	2.524	1.225	0.150	0.025	5.674
CALM							<u>13.247</u>
							100.000

Note: Based on a total of 4,001 hourly observations in the year.

[*] Wind direction is the direction from which the wind is blowing.
Example - the wind is blowing from the east-northeast (ENE) 4.5%
of the hourly observations.

[**] 1 knot = 1.151 miles per hour (mph)

TABLE 3-14

FREQUENCY DISTRIBUTION (%) OF WIND DIRECTION
AND SPEED FOR LOGAN AIRPORT FOR CONCURRENT
HOURS WITH LAWRENCE MUNICIPAL AIRPORT
- 1983 DATA YEAR -

Wind [*] Direction	Wind Speed Class (Knots) [**]						Total
	<u>1-3</u>	<u>4-6</u>	<u>7-10</u>	<u>11-16</u>	<u>17-21</u>	<u>≥ 22</u>	
N	0.225	0.800	2.274	2.074	0.300	0.050	5.724
NNE	0.150	0.525	0.800	1.300	0.350	0.075	3.199
NE	0.175	0.525	1.475	1.550	0.675	0.225	4.624
ENE	0.200	0.550	1.700	1.650	0.225	0.250	4.574
E	0.275	1.100	3.549	3.349	1.000	0.200	9.473
ESE	0.175	0.650	2.374	3.049	0.525	0.100	6.873
SE	0.250	1.025	3.024	1.350	0.100	0.025	5.774
SSE	0.175	0.500	1.200	0.400	0.175	0.100	2.549
S	0.225	0.800	1.850	1.750	0.500	0.075	5.199
SSW	0.075	0.500	1.675	2.849	1.000	0.050	6.148
SW	0.075	0.375	1.900	2.799	0.400	0.100	5.649
WSW	0.125	0.650	2.924	4.474	0.400	0.100	8.673
W	0.125	0.850	3.599	5.899	0.875	0.500	11.847
WNW	0.050	0.500	2.724	4.724	0.875	0.350	9.223
NW	0.025	0.350	2.174	3.074	0.400	0.325	6.348
NNW	0.100	0.325	1.050	1.675	0.325	0.125	3.599
CALM							0.525
							100.001

Note: Based on a total of 4,001 hourly observations in the year, concurrent with hourly observations at the Lawrence Airport.

[*] Wind direction is the direction from which the wind is blowing.
Example - the wind is blowing from the north-northeast (NNE) 3.2% of the hourly observations.

[**] 1 knot - 1.151 miles per hour (mph)

TABLE 3-15

AVERAGE WIND SPEED (EXCLUDING CALMS) AND FREQUENCY
OF OCCURRENCE BY WIND SECTOR FOR CONCURRENT DATA FROM
LAWRENCE MUNICIPAL AIRPORT AND LOGAN AIRPORT
- DATA YEAR 1983 -

<u>Wind Direction</u>	<u>Lawrence Airport</u>		<u>Logan Airport</u>	
	<u>Percent Occurrence</u>	<u>Average Speed (Knots)</u>	<u>Percent Occurrence</u>	<u>Average Speed (Knots)</u>
N	3.4	7.6	5.7	10.0
NNE	3.9	7.8	3.2	11.1
NE	6.0	9.0	4.6	12.0
ENE	4.5	8.6	4.6	10.8
E	6.1	8.0	9.5	10.9
ESE	2.7	8.2	6.9	11.0
SE	2.5	8.6	5.8	8.8
SSE	1.6	7.6	2.6	9.1
S	1.7	7.7	5.2	10.5
SSW	4.7	9.2	6.2	12.3
SW	8.3	8.2	5.7	11.7
WSW	10.4	8.9	8.7	11.2
W	8.9	10.0	11.9	12.2
WNW	8.8	10.2	9.2	12.2
NW	7.7	10.3	6.4	12.0
NNW	5.7	9.1	3.6	11.6
CALM	13.3	-	0.5	-
Average Speed:				
- knots		9.0		11.2
- miles per hour (mph)		10.4		12.9

Note

Basis for comparison: 4,001 data hours as recorded at the Lawrence Municipal Airport, and concurrent data hours from Logan Airport.

TABLE 3-16

BREAKDOWN BY STABILITY CLASS OF LOGAN AIRPORT DATA
 REPRESENTED IN THE 1983 COMPARATIVE DATA BASE

<u>Total Data Year from Logan Airport</u>			<u>Logan Airport Data Used In Comparison with Lawrence Data</u>	
<u>Pasquill-Gifford Stability Class</u>	<u>Percent of Total Year</u>	<u>No. of Hours</u>	<u>Percent of Total Year</u>	<u>No. of Hours</u>
A	0.10	9	0.10	9
B	1.94	170	1.93	169
C	9.32	817	7.91	693
D	69.95	6128	32.43	2841
E	12.26	1074	2.41	211
F	<u>6.42</u>	<u>562</u>	<u>0.89</u>	<u>78</u>
Totals:	99.99	8760	45.67	4001

Table 3-17 presents average wind speeds as a function of stability class. The values for "A" stability are considered unreliable since they represent only 9 data points. For the remaining stability classes, average wind speed comparisons show:

- Class B - Lawrence and Logan roughly equal.
- Class C - Logan higher than Lawrence.
- Class D - Logan higher than Lawrence.
- Class E - Logan higher than Lawrence.
- Class F - Logan lower than Lawrence.

3.3.4 Implications of Meteorological Differences

The U.S. Environmental Protection Agency (U.S. EPA) provides guidance on techniques employed in air quality modeling [38]. The guideline is clear in preferring that on-site meteorological data be used in modeling analyses, since using on-site data is virtually the only way that site-specific meteorological and terrain features will be adequately represented in the analysis. When on-site data are used, a period of one year is considered adequate.

U.S. EPA recognizes, however, that to require each proposed new source of air pollutant emissions to install a meteorological monitoring station years before construction commences would impose a severe burden on plant developers, particularly in light of permitting uncertainties and construction scheduling. For this reason, standard practice has been to allow modeling using five years of off-site meteorological data, provided the data are "reasonably" representative of conditions at the plant site (note that the term "reasonably" is open to interpretation, since it is an unrealistic expectation that off-site conditions would be exactly equivalent to on-site conditions). Compared with the use of an one-year meteorological data record, a five-year data record contains five times the combinations of hourly meteorological conditions to help provide that the "worst-case" conditions would be reflected in the modeling results for each of the pollutant averaging periods.

Observed differences in meteorological conditions between the Logan Airport data and the data recorded at the Lawrence Airport, in concert with the estimated relationship between conditions at Lawrence Airport and the OHA plant site lead to conclusions regarding the modeling for both the ash monofill and stack emissions. These are discussed in the following sections.

Ash Monofill

As has been pointed out in the recent Sigma report [37], the highest predicted concentrations from the ISC Model would be expected under stable conditions with low wind speed. This was verified by a daytime/nighttime modeling analysis, the results of which are summarized in Table 3-18.

TABLE 3-17

COMPARISON OF AVERAGE WIND SPEED BY STABILITY CLASS
 (CALMS EXCLUDED) FOR ALL HOURS IN THE 1983
 COMPARATIVE DATA BASE

<u>Pasquill-Gifford</u> <u>Stability Class</u>	<u>Lawrence Airport</u> <u>Average</u> <u>Speed (knots)</u>	<u>Logan Airport</u> <u>Average</u> <u>Speed (Knots)</u>
A	5.7	4.1
B	6.4	6.3
C	7.7	9.2
D	9.6	12.5
E	6.8	7.7
F	5.9	4.8

Note

Basis for comparison: 4,001 data hours as recorded at the Lawrence Municipal Airport, and concurrent data hours from Logan Airport.

TABLE 3-18

PREDICTED 1983 ANNUAL AVERAGE TOTAL PARTICULATE
CONCENTRATIONS FROM MONOFILL ASH EMISSIONS AT
CRITICAL RECEPTORS GIVEN AS DAYTIME, NIGHTTIME,
AND TOTAL HOURS

<u>Receptor</u>	<u>Total Annual Average Concentration (ug/m³)</u>	<u>Percent of Total Annual Average Concentration From:</u>	
		<u>Daytime Hours</u>	<u>Nighttime Hours</u>
Spring Hill Farm	0.00021	22.5	77.5
Crystal Lake	0.00006	35.8	64.2
Maximum Exposed Individual	0.00749	25.8	74.2

Note

Predicted annual average concentrations based on ISCST modeling results using 1983 meteorological data from Logan Airport. The emission rate of ash from the north monofill site (see Figure 3-1) was equal to 0.43 lb/day.

The monofill modeling done in support of the health risk assessment, as presented by OHA, used conservative assumptions. For example, deposition velocity was not calculated on an hourly basis as a function of friction velocity, but was assumed constant. Also, monofill emission rates were calculated using an emission factor algorithm in which the emission rate is directly proportional to wind speed. Here again, the conservative approach assumed a constant wind speed.

Should OHA wish to refine this analysis, a lower predicted concentration might result by taking into account the effects of low wind speed on deposition velocity and emission rates. On the other hand, this might be offset to some extent by the increased emissions during periods of high winds.

The Task Force has two major concerns regarding monofill emissions and the acceptability of modeling them using Logan Airport data. These are:

- (1) The effects of terrain channeling near the plant site are not taken into account for ground-level emission sources.
- (2) The data comparison does not provide assurance that the occurrence of winds under stable conditions and low wind speed are represented to the extent they might occur at low levels in the Merrimack River valley.

Stack Emissions

The wind roses and other analyses presented in this report indicate that conditions of wind speed and direction at the Logan and Lawrence Airports are similar, at least during the hours where there was concurrent data. There was no comparison of stability class since the only reporting station with sufficient data to allow derivation of stability class was Logan Airport.

Were terrain features not a factor, the differences in meteorological data bases might only alter the location of maximum impact without changing the value. However, terrain features are not uniform, so there is a more complex relationship between wind conditions and terrain than can be quantified by simply looking at the meteorological patterns.

3.3.5 Findings of Task 3 Review and Evaluation

Modeling for the OHA facility was originally done using five years of off-site meteorological data to demonstrate compliance with the federal and state air quality standards, Prevention of Significant Deterioration (PSD) increments, and state policy guidelines. This approach was pre-approved by DEQE through established modeling protocol procedures. The emphasis on this analysis was on stack emissions, and it appears that the analysis was conducted in accordance with DEQE and EPA guidelines. DEQE approval was given to the OHA project based in part on a successful demonstration of compliance with air quality standards.

For stack emissions, the Logan Airport data appear reasonably representative, particularly for traditional (criteria) pollutants where predicted concentrations were well below standards. Any differences in meteorological conditions between the OHA site and Logan Airport should not result in significant differences in predicted air quality impacts. The use of a five year meteorological data record allows for a greater number of combinations of meteorological conditions to provide that the "worst-case conditions are used in the air quality modeling analysis.

When the Board requested that a health risk assessment be conducted for the proposed OHA facility, the same meteorological data source (Logan Airport) was used in the air quality and deposition analyses. A principal issue of disagreement among the parties has been the results of the health risk assessment for emissions from the ash monofill. Here, many additional pollutants were considered. For the ash monofill sources, the Logan Airport data base is of questionable value. There are two reasons for this. First, local low-level transport and dispersion parameters specific to the OHA site could not be expected to be present in the Logan Airport data. Second, the recent monofill modeling conducted by Sigma Research Corporation has shown that nighttime meteorological conditions contribute greatly to overall annual concentrations. Since no nighttime observations were taken at Lawrence Airport, an hour-by-hour comparison for representativeness has not been possible during the course of this study.

The Task Force has determined that the air quality modeling methodologies used for the health risk studies are reasonable. However, uncertainties remain in the representativeness of the meteorological data base for modeling ash operations. The Task Force recommends that as part of Task 5, OHA conduct an on-site meteorological monitoring program. This program will provide data representative of the conditions influencing landfill emissions as well as conditions at stack height. The collection of stack-top meteorological conditions at the OHA facility will also be used in analyzing the ambient monitoring data to be collected as part of the Task 5 requirements. The location of the monitoring station and the instrumentation and procedures used in collecting data should be subjected to rigorous review by DEQE prior to implementation to ensure that the program is in accordance with DEQE and EPA requirements. After one year of data have been collected, the entire facility can then be remodeled to the extent necessary as determined upon review of the data, and in accordance with a protocol acceptable to DEQE.

3.4 TASK 4: Review and Evaluation of Interactive Modeling of Existing Sources in the Haverhill Area

3.4.1 Review and Evaluation of Emission Rate Data

Ogden Haverhill Associates (OHA) submitted an "Air Quality Impact Assessment" document in June 1986 [1] for its proposed 1650 tons per day (TPD) solid waste to energy facility in Haverhill, Massachusetts. As part of the air quality assessment, an emissions inventory of existing major sources near the OHA facility was developed. Based on established annual emissions and distance criteria, source stack parameters and emission rates for sulfur dioxide (SO₂) and particulate matter (PM) were obtained for the major background sources from the DEQE.

The U.S. EPA ISCST model [41] was used with five years of meteorological data from Logan Airport (1979-1983) to predict the maximum impact of emissions from the OHA facility and the major background sources. The predicted worst-case pollutant concentrations were added to ambient background concentrations and the total pollutant concentrations were shown to be in compliance with the appropriate ambient standards.

The Board requested in Information Request (IR) Set V (Question 29) that OHA identify and discuss quantitatively the contributions of other sources within a 30 kilometer (km) [approximately 19 miles] radius from the OHA site. In response to IR Set V (Question 29), OHA identified two other resource recovery facilities in the Haverhill area. The Ogden-Lawrence RDF facility, located approximately 7.4 km (4.6 miles) southwest of the Haverhill site, is designed to burn refuse-derived fuel (RDF) processed at the OHA site. The North Andover NESWC facility, located approximately 4.4 km (2.7 miles) south of the OHA site, is designed to burn approximately 1600 tons per day of solid waste.

OHA Emission Rate Calculations

Emission rates for the pollutants of interest for the Ogden-Lawrence and North Andover facilities were estimated using scaling factors for inorganic and organic pollutants. The scaling factors were developed by OHA and used to estimate emission rates for pollutants for which no test data were available at the time of the study.

For the North Andover NESWC facility, the emission rates for inorganic pollutants were calculated by multiplying the inorganic pollutant emission rates used for the OHA facility by a scaling factor. The scaling factor was equal to the product of the particulate emission rate (gr/dscf) times the volumetric flowrate for the NESWC facility divided by the particulate emission rate times the volumetric flowrate for the OHA facility.

The emission rates for organic pollutants at the NESWC facility were estimated by multiplying the organic pollutant emission rates used for the OHA facility by a different scaling factor. This scaling factor was equal to the product of the TCDD toxic equivalent emission rate times the volumetric flowrate for the NESWC facility divided by the TCDD toxic equivalent emission rate times the volumetric flowrate for the OHA facility.

For the Ogden-Lawrence RDF facility, the emission rates for inorganic pollutants were calculated by multiplying the inorganic pollutant emission rates used for the OHA facility by a scaling factor. The scaling factor was equal to the product of the particulate emission rate (gr/dscf) times the volumetric flowrate times a steam load factor for the Lawrence facility divided by the particulate emission rate times the volumetric flowrate for the OHA facility. The steam load factor was added to take into account that the stack test was conducted when the Lawrence facility was not operating at its maximum steam load.

The emission rates for organic pollutants for the Lawrence facility were estimated by multiplying the organic pollutant emission rates used for the OHA facility by a different scaling factor. This scaling factor was equal to the product of the TCDD toxic equivalent emission rate times the volumetric flowrate times a steam load factor for the Lawrence facility divided by the TCDD toxic equivalent emission rate times the volumetric flowrate for the OHA facility.

Table 3-19 presents the estimated stack emission rates for the two existing MSW facilities in the Haverhill area. Only the pollutants that have been found to be important in the health risk assessment (as required by the Board) have been shown in Table 3-19.

In addition, Table 3-19 presents the pollutant emission rates used in health risk assessment for the OHA facility along with inorganic and organic scaling factors used to estimate the pollutant emission rates for the Lawrence and NESWC facilities. Based on the scaling factors determined for inorganic compounds by OHA in their health risk assessment, the Lawrence emission rates are 38 percent higher and the NESWC facility are 18 percent higher than the inorganic emission rates for the OHA facility, respectively. The emission rate of TCDD toxic equivalents for the Ogden-Lawrence facility was estimated to be almost equal to the emission rate for the OHA facility while the TCDD toxic equivalent emission rate for the NESWC facility was estimated to be almost seven times higher.

Source Sampling Emissions Data

Current stack emissions data obtained from compliance testing reports for the Ogden-Lawrence RDF and North Andover NESWC facilities were evaluated by the Task Force and compared with the pollutant emission rates used by OHA in the risk assessment evaluation for the two existing facilities.

The Massachusetts DEQE reviewed the stationary source sampling report for the compliance emission tests conducted at the Ogden-Lawrence RDF facility in August and September 1988 [39]. Based on the analysis of the emissions data, the sampling results were summarized and presented in a format suitable for use in an air quality modeling study.

Table 3-20 compares the pollutant emission rates used by OHA in the health risk assessment for the Lawrence facility to the emission rates obtained from the compliance emission tests. In comparing the pollutant emission

TABLE 3-19

ESTIMATED STACK EMISSION RATES
FROM THE EXISTING MSW FACILITIES
IN THE HAVERHILL AREA

COLUMNS	[A]	[B]	[C]
Pollutant	Estimated (*) Haverhill OHA Emission Rates (g/sec)	Lawrence Emission Rates (g/sec)	NESWC Emission Rates (g/sec)
INORGANIC COMPOUNDS			
- Scaling Factor -	1.0	1.38	1.18
Particulate Matter	5.40E-01	7.44E-01	6.37E-01
Arsenic (As)	2.86E-04	3.94E-04	3.37E-04
Cadmium (Cd)	2.20E-03	3.03E-03	2.59E-03
Nickel (Ni)	1.14E-02	1.57E-02	1.34E-02
Lead (Pb)	4.64E-02	6.39E-02	5.47E-02
Chromium VI	2.30E-05	3.17E-05	2.71E-05
ORGANIC COMPOUNDS			
- Scaling Factor -	1.0	0.96	6.98
2,3,7,8 TCDD Toxic Equivalents	5.84E-08	5.61E-08	4.1E-07

(*) Estimated Haverhill stack emission rates used in the OHA health risk assessment.

Notes:

- (1) Pollutant emission rates shown were used in the health risk assessments conducted for the Ogden-Lawrence RDF and North Andover NESWC facilities in November 1987.
- (2) Scaling factors used to estimate emissions rates for the Lawrence and NESWC facilities are based on the emission rates developed for the OHA facility.

TABLE 3-20

COMPARISON BETWEEN ESTIMATED AND ACTUAL STACK EMISSION RATES
FOR THE OGDEN-LAWRENCE RDF FACILITY

COLUMNS	[A]	[B]	[C]
Pollutant	Estimated (*) Haverhill OHA Emission Rates (g/sec)	Ogden-Lawrence RDF Facility Estimated Emission Rates (g/sec)	Ogden-Lawrence RDF Facility Actual Emission Rates (g/sec)
INORGANIC COMPOUNDS			
- Scaling Factor -	1.0	1.38	NA
Particulate Matter	5.40E-01	7.44E-01	3.22E-01
Arsenic (As)	2.86E-04	3.94E-04	ND
Cadmium (Cd)	2.20E-03	3.03E-03	61.50E-03
Nickel (Ni)	1.14E-02	1.57E-02	6.27E-02
Lead (Pb)	4.64E-02	6.39E-02	0.69E-03
Chromium VI	2.30E-05	3.17E-05	8.20E-03
ORGANIC COMPOUNDS			
- Scaling Factor -	1.0	0.96	NA
2,3,7,8 TCDD Toxic Equivalents	5.84E-08	5.61E-08	5.00E-08(+)

(ND) Not detected or did not meet all qualitative identification criteria.

(NA) Not applicable - scaling factors not used to estimate emission rates. Pollutant emission rates determined from stack sampling results from each facility.

(*) Estimated Haverhill stack emission rates used in the OHA health risk assessment.

(+) Based on analysis of stack sampling tests as shown in Table 3-21.

rates shown in Table 3-20, some emission rates obtained from the stack compliance tests (Column C) were higher than the emission rates used by OHA in the risk assessment (Column B). Emissions of chromium VI were measured to be over 250 times higher than the emission rate calculated by scaling the chromium VI emission rate used in the OHA risk assessment analysis. As discussed in the evaluation of the OHA stack emission rates (Section 3.1.3 of this report), the chromium VI emission rate used by OHA in the risk assessment due to stack emissions from the OHA facility appear to be much lower than values used for other resource recovery facilities. However, arsenic, one of the key pollutants for the OHA health risk assessment, was not detected during the stack sampling tests conducted at the Lawrence facility. Consequently, a comparison of actual and estimated emission rates of arsenic cannot be performed.

Table 3-21 summarizes the PCDD/PCDF emission rates measured at the Ogden-Lawrence RDF facility in August 1988. All concentrations have been presented in nanograms per dry standard cubic meter (ng/dscm) corrected to 12% CO₂ with emission rates given in grams per second (g/sec). In addition, the table provides the results of the 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA's toxicity scheme [11]. The 2,3,7,8 TCDD toxic equivalent emission rate was measured to be 5.0×10^{-8} [5.0E-08] g/sec. As shown in Table 3-20, the 2,3,7,8 TCDD toxic equivalent emission rate used in the OHA air quality analysis (Column B) is approximately 10 percent higher than the actual emission rate measured at the Lawrence facility (Column C).

The Massachusetts DEQE also reviewed the stationary source sampling report for the compliance emission tests conducted at the North Andover NESWC facility in August and September 1988 [40]. DEQE reviewed and summarized the stack sampling data and presented the results in a format suitable for use in an air quality modeling study.

Table 3-22 compares the pollutant emission rates used by OHA in the health risk assessment for the NESWC facility to the emission rates obtained from the compliance emission tests. In comparing the pollutant emission rates shown in Table 3-22, some emission rates obtained from the stack compliance tests (Column C) were higher than the emission rates used by OHA in the health risk assessment (Column B).

The particulate matter emission rate at the NESWC facility was measured to be almost twice as high as that used by OHA in their air quality analysis. The emission rate of arsenic based on the stack sampling tests was found to be approximately five times higher than the emission rate calculated by OHA using the scaling factor approach. Stack sampling tests were conducted for total chromium but not for chromium VI. In the sampling tests conducted in 1988, the total chromium emission rate was calculated to be 0.002 grams per second (g/sec). The chromium VI emission rate shown in Table 3-22 (Column C) was calculated based on the assumption that 5 percent of the total measured chromium emissions were in the carcinogenic form, chromium VI. With this conservative assumption, the chromium VI emission rate is determined to be approximately four times higher than the emission rate used in the OHA risk assessment.

TABLE 3-21

PCDD/PCDF EMISSIONS SUMMARY
 OGDEN-LAWRENCE RDF FACILITY - ESP OUTLET
 Three-Run Averages (August 1988)

PCDD/PCDF Isomer	Average Sample Collected (nanograms)	Emission Rate (grams/sec)	2,3,7,8 TCDD Toxic Equiv. Factor	2,3,7,8 TCDD Toxic Equivalents Emission Rate (grams/sec)
Dioxins (PCDD)				
Total MCDD	ND	0.0E+00	0.0E+00	0.0E+00
Total DCDD	ND	0.0E+00	0.0E+00	0.0E+00
Total TriCDD	1.9E+00	2.4E-08	0.0E+00	0.0E+00
2378-TCDD	3.4E-01	4.2E-09	1.0E+00	4.2E-09
Other TCDD	6.4E+00	8.0E-08	1.0E-02	8.0E-10
12378-PCDD	5.3E-01	6.6E-09	5.0E-01	3.3E-09
Other PCDD	9.6E+00	1.2E-07	5.0E-03	5.9E-10
123478-HxCDD	1.1E+00	1.3E-08	4.0E-02	5.3E-10
123678-HxCDD	1.2E+00	1.5E-08	4.0E-02	6.0E-10
123789-HxCDD	1.9E+00	2.4E-08	4.0E-02	9.6E-10
Other HxCDD	1.2E+01	1.5E-07	4.0E-04	6.0E-11
1234678-HpCDD	8.9E+00	1.1E-07	1.0E-03	1.1E-10
Other HpCDD	1.1E+01	1.3E-07	1.0E-05	1.3E-12
OCDD	1.2E+01	1.4E-07	0.0E+00	0.0E+00
Total PCDD	6.6E+01	8.2E-07		1.1E-08
Furans (PCDF)				
Total MCDF	3.2E-01	4.0E-09	0.0E+00	0.0E+00
Total DCDF	5.7E-01	7.1E-09	0.0E+00	0.0E+00
Total TriCDD	5.9E+01	7.3E-07	0.0E+00	0.0E+00
2378-TCDF	1.6E+01	1.9E-07	1.0E-01	1.9E-08
Other TCDF	7.5E+01	9.3E-07	1.0E-03	9.3E-10
12378-PCDF	6.0E+00	7.4E-08	1.0E-01	7.4E-09
23478-PCDF	6.9E+00	8.6E-08	1.0E-01	8.6E-09
Other PCDF	5.1E+01	6.3E-07	1.0E-03	6.3E-10
123478-HxCDF	8.5E+00	1.0E-07	1.0E-02	1.0E-09
123678-HxCDF	6.6E+00	8.1E-08	1.0E-02	8.1E-10
234678-HxCDF	4.6E+00	5.7E-08	1.0E-02	5.7E-10
123789-HxCDF	2.1E-01	2.6E-09	1.0E-02	2.6E-11
Other HxCDF	2.0E+01	2.4E-07	1.0E-04	2.4E-11
1234678-HpCDF	1.3E+01	1.6E-07	1.0E-04	1.6E-11
1234789-HpCDF	3.4E-01	4.3E-09	1.0E-04	4.3E-13
Other HpCDF	5.2E+00	6.4E-08	1.0E-05	6.4E-13
OCDF	2.8E+00	3.4E-08	0.0E+00	0.0E+00
Total PCDF	2.7E+02	3.4E-06		3.9E-08
Total - 1 Unit	3.4E+02	4.2E-06		5.0E-08

(ND) Not detected or did not meet all qualitative identification criteria.

TABLE 3-22

COMPARISON BETWEEN ESTIMATED AND ACTUAL STACK EMISSION RATES
FOR THE NORTH ANDOVER NESWC FACILITY

COLUMNS	[A]	[B]	[C]
Pollutant	Haverhill OHA Emission Rates (g/sec)	North Andover NESWC Facility Estimated Emission Rates (g/sec)	North Andover NESWC Facility Actual Emission Rates (g/sec)
INORGANIC COMPOUNDS			
- Scaling Factor -	1.0	1.18	NA
Particulate Matter	0.54E+00	0.64E+00	1.19E+00
Arsenic (As)	2.86E-04	3.37E-04	18.0E-04
Cadmium (Cd)	2.20E-03	2.59E-03	2.60E-03
Nickel (Ni)	1.14E-02	1.34E-02	0.26E-02
Lead (Pb)	4.64E-02	5.47E-02	2.04E-02
Chromium VI	2.30E-05	2.71E-05	10.0E-05(*)
ORGANIC COMPOUNDS			
- Scaling Factor -	1.0	6.98	NA
2,3,7,8 TCDD Toxic Equivalents	5.84E-08	40.7E-08	6.20E-08(+)

(ND) Not detected or did not meet all qualitative identification criteria.

(NA) Not applicable - scaling factors not used to estimate emission rates.

(*) Chromium VI not measured. Chromium VI emission rate shown is based on the assumption that 5 percent of measured total chromium emission rate (2.0E-03 g/sec) is chromium VI.

(+) Based on analysis of stack sampling tests as shown in Table 3-23.

Table 3-23 summarizes the PCDD/PCDF emission rates measured at the ESP outlet of Unit 1 at the North Andover NESWC facility in August 1988. All concentrations have been presented in nanograms per dry standard cubic meter (ng/dscm) corrected to 12% CO₂ with emission rates given in grams per second (g/sec). The 2,3,7,8 TCDD toxic equivalent emission rate, based on the U.S. EPA's toxicity scheme, was measured to be 3.1×10^{-8} [3.1E-08] g/sec. Because the NESWC facility consists of two identical units, the total 2,3,7,8 TCDD toxic equivalent stack emissions for the NESWC facility was estimated to be 6.2×10^{-8} g/sec. As shown in Table 3-22, the 2,3,7,8 TCDD toxic equivalent emission rate used in the OHA air quality analysis (Column B) is over six times higher than the actual emission rate measured at the NESWC facility (Column C).

3.4.2 Review and Evaluation of Stack Parameters used in Interactive Modeling

In the "Air Quality Impact Assessment" document prepared by OHA in 1986, existing major background sources were identified. In order to include major background sources in the air quality modeling (source interaction) analysis, source stack parameters and SO₂ and PM emission rates were obtained for the major background sources from the Massachusetts DEQE.

Table 3-24 summarizes the stack parameters used in the air quality modeling analysis conducted by OHA for the risk assessment conducted for the Ogden-Lawrence RDF and North Andover NESWC facilities. Based on a review by the Task Force of source information and stack sampling results for the two facilities, Table 3-24 provides the key stack parameters for the two facilities. As shown in Table 3-24, the stack parameters proposed by OHA to be used for the two existing sources are nearly identical to the values determined by the Task Force. Although no computer printouts of the air quality (ISCLT) modeling runs were presented in the Record for review and verification by the Task Force, it appears that OHA used acceptable stack parameters for the two existing facilities.

3.4.3 Findings of Task 4 Review and Evaluation

In response to the request in IR Set V (Question 29) that OHA identify and evaluate the other resource recovery sources within a 30 kilometer (approximately 19 miles) from the OHA site, OHA identified two other resource recovery facilities in the Haverhill area. The Ogden-Lawrence RDF facility, located approximately 4.6 miles southwest of the Haverhill site, is designed to burn refuse-derived fuel (RDF) processed at the existing OHA facility. The North Andover NESWC facility, located approximately 2.7 miles south of the Haverhill site, is designed to burn approximately 1600 tons per day of solid waste.

In the air quality and health risk assessments conducted for the two existing facilities, air quality dispersion models were used to estimate ambient air quality concentrations and deposition rates due to pollutant emissions

TABLE 3-23

PCDD/PCDF EMISSIONS SUMMARY
NORTH ANDOVER NESWC FACILITY - UNIT NO. 1 ESP OUTLET
Four-Run Averages (August 1988)

PCDD/PCDF Isomer	Average	Emission Rate (grams/sec)	2,3,7,8	Average 2,3,7,8	Emission Rate (grams/sec)
	Concentration (ng/DSCM) (12% CO ₂)		TCDD Toxic Equiv. Factor	TCDD Toxic Equivalents Concentration (ng/DSCM) (12% CO ₂)	
Dioxins (PCDD)					
Total MCDD	ND	ND	0.0E+00	0.0E+00	0.0E+00
Total DCDD	1.7E-01	5.0E-09	0.0E+00	0.0E+00	0.0E+00
Total TriCDD	8.0E-01	2.4E-08	0.0E+00	0.0E+00	0.0E+00
2378-TCDD	1.4E-01	4.2E-09	1.0E+00	1.4E-01	4.2E-09
Other TCDD	2.6E+00	7.7E-08	1.0E-02	2.6E-02	7.7E-10
12378-PCDD	1.7E-01	5.1E-09	5.0E-01	8.5E-02	2.6E-09
Other PCDD	3.5E+00	1.0E-07	5.0E-03	1.8E-02	5.2E-10
123478-HxCDD	2.8E-01	8.5E-09	4.0E-02	1.1E-02	3.4E-10
123678-HxCDD	7.9E-01	2.4E-08	4.0E-02	3.1E-02	9.4E-10
123789-HxCDD	8.8E-01	2.6E-08	4.0E-02	3.5E-02	1.0E-09
Other HxCDD	6.8E+00	2.0E-07	4.0E-04	2.7E-03	8.2E-11
1234678-HpCDD	4.4E+00	1.3E-07	1.0E-03	4.4E-03	1.3E-10
Other HpCDD	4.1E+00	1.2E-07	1.0E-05	4.1E-05	1.2E-12
OCDD	6.9E+00	2.1E-07	0.0E+00	0.0E+00	0.0E+00
Total PCDD	3.2E+01	9.4E-07		3.5E-01	1.0E-08
Furans (PCDF)					
Total MCDF	5.0E-01	1.5E-08	0.0E+00	0.0E+00	0.0E+00
Total DCDF	4.2E+00	1.2E-07	0.0E+00	0.0E+00	0.0E+00
Total TriCDD	1.8E+01	5.6E-07	0.0E+00	0.0E+00	0.0E+00
2378-TCDF	1.1E+00	3.4E-08	1.0E-01	1.1E-01	3.4E-09
Other TCDF	2.1E+01	6.3E-07	1.0E-03	2.1E-02	6.3E-10
12378-PCDF	1.7E+00	5.2E-08	1.0E-01	1.7E-01	5.2E-09
23478-PCDF	2.8E+00	8.5E-08	1.0E-01	2.8E-01	8.5E-09
Other PCDF	1.2E+01	3.6E-07	1.0E-03	1.2E-02	3.6E-10
123478-HxCDF	3.6E+00	1.1E-07	1.0E-02	3.6E-02	1.1E-09
123678-HxCDF	1.7E+00	4.9E-09	1.0E-02	1.7E-02	4.9E-10
234678-HxCDF	3.2E+00	9.5E-08	1.0E-02	3.2E-02	9.5E-10
123789-HxCDF	3.6E-01	1.1E-08	1.0E-02	3.6E-03	1.1E-10
Other HxCDF	5.2E+00	1.6E-07	1.0E-04	5.2E-04	1.6E-11
1234678-HpCDF	4.8E+00	1.4E-07	1.0E-04	4.8E-04	1.4E-11
1234789-HpCDF	9.3E-01	2.8E-08	1.0E-04	9.3E-05	2.8E-12
Other HpCDF	2.4E+00	7.3E-08	1.0E-05	2.4E-05	7.3E-13
OCDF	1.3E+00	3.8E-08	0.0E+00	0.0E+00	0.0E+00
Total PCDF	8.6E+01	2.5E-06		6.9E-01	2.1E-08
Total - 1 Unit	1.2E+02	3.5E-06		1.0E+00	3.1E-08
Total - 2 Units	-	7.0E-06		-	6.2E-08

(ND) Not detected or did not meet all qualitative identification criteria.

TABLE 3-24

STACK PARAMETERS USED IN THE AIR QUALITY ANALYSIS
OF THE EXISTING MSW FACILITIES
IN THE HAVERHILL AREA

Stack Parameters	Ogden-Lawrence	RDF Facility	NESWC Facility	
	OHA Assessment [1]	Task Force Review	OHA Assessment [1]	Task Force Review
Stack Height				
Feet (ft.)	320.0	320.0	230.0	230.0
Meters (m)	97.5	97.5	70.1	70.1
Stack Base Elev.				
Feet (ft.)	70.0	70.0	75.0	75.0
Meters (m)	21.3	21.3	22.9	22.9
Stack Diameter				
Feet (ft.)	20.0	20.0	9.8	9.9
Meters (m)	6.1	6.1	3.0	3.0
Exit Temperature				
(°F)	342.0	309.5	455.0	413.0
(°K)	445.0	427.2	508.0	484.7
Exit Velocity				
(fps)	12.7	11.3	78.4	69.3
(m/s)	3.9	3.5	23.9	21.1
Flue Volumetric Flowrate (*)				
(acfm)	239,400	213,000	354,800	320,000
(acmm)	6,800	6,030	10,140	9,060

(*) Actual cubic feet per minute at stack conditions (acfm)
Actual cubic meters per minute at stack conditions (acmm)

from each facility. The air quality modeling results were used in separate risk assessments conducted for each facility to estimate the health risk on human receptors. In order to evaluate the appropriateness of the emissions data and modeling assumptions used by OHA for the two existing facilities, pollutant emissions rates and stack parameters used in the air quality analysis were reviewed and compared with facility information provided by the Massachusetts DEQE.

Specific pollutant emission rates were determined by OHA's consultants for the Ogden-Lawrence and North Andover facilities by using stack sampling results for particulate matter and dioxins/furans with scaling factors developed for inorganic and organic pollutants. The scaling factors were developed by OHA and used to estimate stack emission rates for pollutants for which no test data were available at the time of the study. For the most part, the scaling factors were calculated by comparing the known particulate and dioxins/furans emission rates and volumetric flowrates (based on stack sampling tests) for the two existing facilities with the particulate and dioxins/furans emission rates used in the OHA health risk assessment.

Based on the scaling factor calculated by OHA's consultants for inorganic compounds, the pollutant emission rates for the Ogden-Lawrence and North Andover facilities were 38 and 18 percent, respectively, higher than the inorganic emission rates used for the health risk analysis for the stack emissions for the OHA facility. The emission rate of 2,3,7,8 TCDD toxic equivalents for the Ogden-Lawrence RDF facility was estimated to be almost equal to the emission rate for the OHA facility while the 2,3,7,8 TCDD toxic equivalents for the NESWC facility was estimated to be almost seven times higher.

In August and September 1988, the Massachusetts DEQE reviewed the stationary source sampling reports prepared for the compliance emission tests conducted at the Lawrence and North Andover facilities. Based on the analysis of the emissions data included in these reports, the stack sampling results were summarized and presented in a format suitable for use in an air quality modeling study [39, 40].

The Task Force found that the emission rates of most pollutants, based on the stack compliance tests conducted in 1988, were higher than the emission rates used by OHA in the health risk assessment for the Lawrence facility. Emission rates for chromium VI were measured to be over 250 times higher than the emission rate calculated by using a scaling factor approach. As discussed in Section 3.1.3 (Task 1) of this report, the chromium VI emission rates used by OHA in the risk assessment due to stack emissions from the OHA facility appear to be much lower than values used in other recent resource recovery health risk assessments. However, arsenic, which appears to contribute more to the over estimated risk, was not detected at the Lawrence facility during the 1988 stack sampling tests.

The dioxins/furans emissions measured at the Ogden-Lawrence facility in August 1988 were converted to estimate the 2,3,7,8 TCDD toxic equivalents emission rate based on the U.S. EPA's toxicity scheme [11]. The 2,3,7,8 TCDD toxic equivalents emission rate was calculated to approximately 10 percent lower than the emission rate used in the OHA air quality analysis.

For the North Andover NESWC facility, the pollutant emission rates obtained from the stack compliance tests were higher than the emission rates used by OHA in the health risk assessment. The particulate emission rate at the NESWC facility was measured to be almost twice as high as the particulate emission rate presented in the NESWC health risk assessment material. The emission rate of arsenic based on the stack sampling tests (as summarized by the DEQE) was found to be approximately five times higher than the emission rate calculated by OHA using the scaling factor approach. Stack sampling tests were conducted for total chromium but not for chromium VI. Assuming that five percent of the total measured chromium emissions are in the hexavalent carcinogenic form, the chromium VI emission rate would be approximately four times higher than the emission rate used in the OHA risk assessment.

Dioxins/furans emission rates were measured at the ESP outlet of Unit 1 at the NESWC facility in 1988. Taking into account that the NESWC facility consists of two identical units, the total 2,3,7,8 TCDD toxic equivalent emission rate, based on the U.S. EPA's toxicity scheme, for the NESWC facility was calculated to be over six times lower than the stack emission rate used in the health risk assessment analysis.

The stack parameters used by OHA in the air quality modeling analyses conducted for the Lawrence and North Andover facilities were nearly identical to the values obtained by the Task Force from the DEQE.

4.0 SUMMARY AND CONCLUSIONS

4.1 Summary and Conclusions for Task 1

In order to compare the stack emissions data used in the OHA's ambient air quality and health risk assessments with stack emissions data from other resource recovery plants, the stack emissions data from the different facilities had to be compared on a standard basis. Air quality dispersion models, which are used to estimate the impact of pollutants on human receptors, normally require that emission rates be input in the units of grams per second (g/sec). With the health risk assessments conducted for the OHA facility based on the results of the air quality modeling analyses, the stack emissions data used in the OHA's ambient air quality and health risk assessments were compared with stack emissions from other similar facilities in the units of g/sec.

In 1986 and 1987, lacking stack emission data from an existing facility with a dry scrubber/ESP that is comparable with the air pollution control technology proposed for the Haverhill facility, OHA extrapolated emission data from an existing facility in Zurich, Switzerland that has been retrofitted with a dry scrubber. The Millbury facility, which consists of two identical units became operational in September 1987, is considered to be the first application of a spray dryer absorber/ESP control system on a municipal waste combustor in North America.

The design capacity of the Millbury facility is 750 tons per day (TPD) for each unit while the capacity of one unit at the OHA facility is 825 TPD. Particulate emissions from the Millbury facility are controlled using a three-field ESP with a permit limit of 0.030 gr/dscf corrected to 12% CO₂. The OHA facility with a dry scrubber/four-field ESP has a maximum particulate emission rate limit of 0.015 gr/dscf corrected to 12% CO₂.

The Task Force believes that the OHA facility has a state-of-the-art combustion and air pollution control systems and, if operated and maintained as designed, should result in lower emissions than the Millbury facility. Therefore, after adjusting for the size of each facility, the Millbury stack test data should be considered a conservative estimate of the expected stack emissions from the OHA facility.

The average and maximum (all tests) stack emission rates for pollutants from the Wheelabrator Millbury (MA) facility were calculated based on two stack sampling test periods conducted in February and November 1988. The average Millbury stack emission rates per Unit were calculated based on the average of all sampling runs for Units 1 and 2 for both testing periods. The maximum Millbury stack emission rates per Unit were based on the maximum emission rates measured for all sampling runs at both Units.

To estimate the pollutant emission rates for the OHA facility based on the Millbury stack testing data, the Millbury pollutant emission rates per Unit were multiplied by 2.2 to account for the fact that the OHA facility has two units and is designed to handle 825 TPD per Unit and the Millbury facility 750 TPD per Unit (2 Units x 825 TPD/750 TPD = 2.2).

The average and maximum stack particulate emission rate measured at the Millbury facility was measured to be 0.004 gr/dscf corrected to 12% CO₂ and 0.019 gr/dscf corrected to 12% CO₂, respectively. The total stack particulate emission rate used in the health risk assessment of the OHA facility (0.54 g/sec) is more than 30 percent lower than the average scaled-Millbury emission rate (0.72 g/sec) and more than six times lower than the maximum scaled emission rate (3.42 g/sec) based on the Millbury stack testing data. Although the particulate emission rate used for the OHA facility was underestimated, no credit was given to the fact that the OHA facility has a four-field ESP while the Millbury facility has a three-field system. As discussed above, the particulate emission limit for the OHA facility is 50 percent less than the permit limit for the Millbury facility. Therefore, with the four-field ESP system, one could expect to see lower particulate emission rates from the OHA facility.

While the total stack particulate emission rate used in the health risk assessment (0.54 g/sec) for the OHA facility was lower than the scaled-Millbury particulate emission rates (0.72 g/sec, average all runs), health risk assessments are based on the cancer potency of the specific pollutants, such as the trace metals, emitted from the facility. Therefore, the health risk due to stack emissions is not determined solely on the total particulate emissions but on the specific pollutant emissions.

Without stack emissions data available from an existing facility with comparable air pollution equipment (in 1986 and 1987), the methodology used by OHA to estimate the trace metal emission rates from the Haverhill facility was based on multiplying trace metal weight percentages by the expected typical particulate matter emission rate for the OHA facility. While OHA's analyses (included in the Record) contains several errors and was not consistent with all of the Board's requests, the technical approach has some technical merit. However, the Task Force believes that the scaled-Millbury data gives a better indication of the expected stack emissions from the OHA facility.

Although the Board requested that upper level estimates be used where site specific data is not available, a review of the Record shows that the Board has accepted the use of expected typical emissions in the health risk assessment. Therefore, the Task Force compared the stack pollutant emissions based on the average-scaled Millbury data with the stack emissions data used by OHA in the health risk assessment. With the exception of chromium VI emissions, the trace metal emissions used in the OHA health risk assessment appear to be reasonable based on the comparison with average scaled-Millbury data. The chromium VI emission factor used in the OHA risk assessment is 100 times lower than that used in other risk assessments performed by OHA and as required by other agencies. Therefore, the health risk due to chromium VI emissions could approach one in a million.

In its initial health risk assessment, OHA used the dioxin/furan emissions data from the Zurich Josefstrasse facility with the uncontrolled emissions adjusted by specific isomer removal efficiencies. For the health risk assessment, the controlled dioxin/furan emission rates were expressed in

terms of 2,3,7,8 TCDD toxic equivalents. In trying to reproduce their calculations, the Task Force determined that the 2,3,7,8 TCDD toxic equivalents based on the U.S. EPA toxicity scheme [11] was approximately 32 percent higher than the emission rate used by OHA. It appears that the toxic equivalency factors, which account for the toxicity of each congener, used by OHA were based on an interim document prepared in 1985 and not the final U.S. EPA values as published in 1986.

In the initial stack risk assessment, OHA assumed a 76 percent removal efficiency to estimate the controlled emissions of dioxins and furans from the OHA facility. In June 1988, OHA reported that recent tests conducted at the Zurich Josefstrasse facility measured removal efficiency for dioxins/furans greater than 90 percent.

A paper reported at the Industrial Gas Cleaning Institute [7] in 1988 on the performance of emission control systems on municipal waste combustors reported that spray dryer absorber/fabric filter (SDA/FF) systems were more effective in controlling dioxin and furan emissions than the spray dryer/ESP (SDA/ESP) system as operated at the Millbury facility. While the SDA/FF systems tested measured PCDD/PCDF removal efficiencies greater than 90 percent, the removal efficiency measured at the Millbury facility was calculated to be approximately 70 percent. Based on these results, the use of the Zurich Josefstrasse's higher removal efficiency to further reduce the dioxin/furan emission estimates is not recommended. However, as with the trace metal emission rates, the Task Force expects that the dioxin/furan emission rate would be better estimated by using the average scaled-Millbury data.

In trying to determine whether the pollutant emissions from the OHA facility will present a threat to public health, safety, or the environment, the Board has decided that total potential lifetime cancer risks due to pollutant emissions from the OHA facility should be less than 10 in a million. As calculated by the OHA consultants (see Table 3-8), the estimate of risk due to stack emissions from the OHA facility was calculated to be less than four in a million with emissions of arsenic and 2,3,7,8 TCDD toxic equivalents each accounting for almost 50 percent of the total risk. The final risk due to stack emissions from the OHA facility was estimated by the Board's consultants to be over 14 in a million with almost 85 percent of the risk due to the 2,3,7,8 TCDD toxic equivalent emissions.

The differences between the two health risk estimates made by the Board's and OHA's consultants were mainly due to the following technical issues:

- o Half-life of dioxins in soil
- o Dioxin and arsenic potencies
- o Dioxins/furans emission rates
- o Deposition rates of organics (i.e., dioxins and furans)

While the Agreement did not specifically require the Task Force to evaluate the health risk assessment protocol, an attempt has been made to

extrapolate the findings of this study to the stack health risk conclusions found in the Record. The conclusions reached by the Task Force are as follows:

Half-life of Dioxins in Soil

Based on a final agreement that a 12-year half-life for each isomer of dioxins in the soil is appropriate as a composite value representing the different isomers, the health risk due to all stack emissions calculated by OHA and the Board's consultants would equal four and twelve in a million, respectively.

Dioxin and Arsenic Potencies

The U.S. EPA is considering reducing the current dioxin potency value by a factor of 17. Because these recommendations have not been finalized, no adjustments are warranted to the estimated stack risk. However, the U.S. EPA has recently reduced the arsenic oral potency by a factor of 10. With this recent action, the health risks due to arsenic emissions alone should reduce to less than one in a million. The total health risk due to all stack emissions calculated by OHA and the Board's consultants would then range from approximately four to ten in a million.

Dioxins/Furans Emission Rates

The 2,3,7,8 TCDD toxic equivalents emission rate based on the average scaled-Millbury test data was determined to be almost 50 percent lower than the emission rate used by OHA in the stack risk assessment (see Table 3-7). If the lower 2,3,7,8 TCDD toxic equivalents emission rate is used in the stack health risk assessment, the total health risk due to the stack emissions would range from approximately one to five in a million.

The stack emissions of 2,3,7,8 TCDD toxic equivalents account for the majority of the potential lifetime cancer risks for the OHA facility. It should be noted that OHA did not use the correct toxicity weighting factors in calculating the 2,3,7,8 TCDD toxic equivalents emission rate (used in the stack health risk assessment). Based on the Task Force's calculations, the 2,3,7,8 TCDD toxic equivalents emission rate should have been 32 percent higher than the emission rate used by OHA. If the estimated stack risks (shown in Table 3-8) are adjusted to reflect the higher 2,3,7,8 TCDD toxic equivalents emission rate (see Table 3-3) based on correcting OHA's emission rate using the proper U.S. EPA toxicity scheme, the health risk due to stack emissions would range from two to 13 in a million. However, as stated above, the Task Force believes that the 2,3,7,8 TCDD toxic equivalents emission rate calculated from the average scaled-Millbury test data would better represent the expected emissions from the OHA facility than the methodology presented by OHA. With these scaled emission rates, the total lifetime cancer risk due to all the OHA stack emissions would range from approximately one to five in a million.

In addition, the Task Force has adjusted the health risk due to chromium VI emissions to be consistent with the other risk assessments conducted by Ogden. This adjustment raises the health risk due to all stack emissions to two to six in one million.

Taking into consideration all the adjustments as made above, the Task Force concludes the risk from stack emissions range from two to six in a million, which is below the acceptable value of ten in a million as established by the Board. There are, however, some unresolved issues which contribute to the range variance. To further refine the risk number rather than except a range, the following information would have to be obtained and technical issues resolved:

- (1) Stack emissions data for arsenic, chromium VI, and dioxins/furans based on the stack (compliance) tests to be conducted at the OHA facility.
- (2) Resolution of the deposition modeling approaches for organic pollutants.
- (3) Verification of the toxic equivalent factors to be used in the calculation of the 2,3,7,8 TCDD toxic equivalents emission rate.

4.2 Summary and Conclusions for Task 2

Based on the expected availability of technical information required to complete this study, the proposed work scope was scheduled to be completed in a few month. For this relatively short time period, it was concluded that a short-term on-site monitoring program to measure the fugitive ash emissions at an existing site similar to the Haverhill facility could not be designed, conducted, and analyzed during the course of this study.

To evaluate the appropriateness of the ash emissions rates used in the OHA's health risk assessment, the Task Force evaluated the U.S. EPA emission factor equations used in the analysis and reviewed reported fugitive emission data from existing landfill areas. Ash data was provided by OHA from a soil sampling program conducted at the Woodburn Ash Monofill used by the Marion County Resource Recovery Facility in Oregon [29]. The ash monofill pit that was operated by Marion County did not include daily covering until the pit began to reach final grade level. A review of the sampled soil collected around the pit indicated that pollutant concentrations at the close-in sampling locations were not different from the background samples. However, the soil sampling data cannot be converted into pollutant emission rates needed for the air quality modeling and health risk assessment analyses.

In addition, ambient air monitoring data collected at the ash disposal site at the RESCO Saugus (MA) facility were reviewed by the Task Force to determine if pollutant emission rates could be determined from the four sampling sites on the RESCO ash landfill and one background site, which

was located away from the landfill [18]. The purpose of this monitoring program was to assess the impact of the ash disposal area on the surrounding environment. The ash residue was reported to be present at the surface covering an area of approximately 65 acres and ranged in depth from less than one foot to over 40 feet.

Unlike the proposed ash handling program at the OHA Landfill, the Saugus solid waste disposal area is not covered. It should be noted that the Saugus facility does not have a scrubber air pollution control system and, therefore, the Saugus ash is chemically and physically different than the ash from the OHA facility. Even without daily cover, the Saugus air monitoring data indicated that the transport of particulates off-site did not appear to be occurring because concentrations at the fenceline site were not elevated when the wind was blowing from the ash disposal area toward the monitoring site. However, the air monitoring program was designed to measure ambient air quality concentrations and not to estimate fugitive emission rates from the ash disposal area. No attempt was made to estimate pollutant-specific emission rates using the meteorological monitoring data collected.

With the lack of acceptable empirical data on ash emissions from the disposal and landfiling operations, the fugitive ash emissions due to the ash handling activities at the OHA facility were estimated based on empirical equations developed for the U.S. EPA [19]. In response to the Board's request in IR Set III-A, OHA estimated the hourly fugitive air emissions of ash from the following sources at the OHA facility:

- (1) Ash Handling Building. This includes all systems for handling and loading ash in preparation for transport to the Landfill.
- (2) Ash-Transport Vehicles. This includes the fugitive emissions of ash escaping from the trucks while driving to the Landfill.
- (3) Ash Monofill Area. This includes the fugitive ash emissions at the monofill area due to truck dumping, landfill maintenance activities, and wind erosion of exposed ash surfaces.

Over the 1987-1988 period, OHA submitted screening and refined ash health risk assessments for the fugitive emissions from the above sources as calculated with the U.S. EPA (AP-42) emission factor equations. Based on these analyses, OHA estimated that the potential lifetime cancer risk due to fugitive ash emissions at the point of maximum impact was approximately 4 in a million. Based on the fugitive ash emissions at the OHA facility and corrections made to errors contained in OHA's screening health risk assessment, the Board's consultants estimated that the potential lifetime cancer risk due to ash handling operations would be 190 in a million.

The risk estimate of 190 in a million due to fugitive ash emissions has been a major concern to the Board. Though the Task Force's work scope did not include conducting a revised health risk assessment, the Task Force worked with the technical consultants for both parties in an attempt to reach a closer agreement between the health risk estimates made by each side.

On December 13, 1988, the Board, OHA, and Refuse Fuels Associates (RFA) signed a Modification of Site Assignment by Stipulation that amended the existing Site Assignment for the Ward Hill Neck site. In the Stipulation of Conditions, OHA agreed to modify its ash management procedures to minimize fugitive ash emissions from the OHA facility. Based on the added control measured proposed by OHA to minimize the fugitive ash emissions from the OHA facility, the Board's consultants agreed that the fugitive ash emissions from the ash handling building and the ash transport vehicles should be assumed equal to zero for the air quality analysis (if OHA follows the ash management procedures stated in the Stipulation of Conditions).

After meeting with the Task Force in March 1989 and reviewing additional reports not previously provided, the Board's consultants reduced the screening level health risk due to fugitive ash emissions to a range from one to five in a million. With this finding, it appears that both parties agree that the total excess lifetime cancer risks due to fugitive ash emissions at the monofill should be in the one to five in a million range. Adjusting for the reduced arsenic potency now approved by U.S. EPA, the total lifetime risk due to fugitive ash emissions should be less than one in a million.

The risk estimate is based on extremely low fugitive ash emission rates from the monofill area source that includes the truck dumping, landfill maintenance activities, and wind erosion of the exposed ash surface. The Task Force acknowledges that the U.S. EPA AP-42 emission factor equations are not designed specifically for the prediction of ash fugitive emissions.

The fugitive emission factor equations were formulated based on field tests and provide empirical relationships of emissions based on material properties, handling practices, and environmental factors. The utility of these emission factors is dependent on the availability of the appropriate parameters. The emission factor equations must be used with caution even if parameters are available for the specific material and process parameters.

Emission rates were estimated for typical materials handling equipment and expected ash properties. The estimation of emission rates for the OHA facility focused on three source areas: the ash handling building, the ash transport vehicles as they travel between the ash handling building and the monofill area, and the material handling activities at the monofill.

The ash from a mass-burn incinerator consists of bottom ash and fly ash. Bottom ash and fly ash are both collected and conveyed in a manner that promotes wetting of the ash. The ash is partially dewatered with the ash moisture level reported to be in the 15 to 20 percent range. The ash, at this point, has been described in appearance and composition to wet cement [42]. The wet ash is then loaded into covered, watertight trucks for transport to the monofill. If OHA follows the ash management procedures contained in the Stipulation of Conditions [24] including maintaining the ash moisture content at approximately 20 percent or at a level sufficient to minimize fugitive ash emissions, the Task Force believes that it is reasonable to assume that the emissions from the ash handling building and the ash transport vehicles are zero.

Based on the ash management plans proposed by OHA, the Board's consultant estimated that the total fugitive ash emissions at the monofill would range from 0.13 to 0.43 pounds per day (lb/day) [28]. This emission estimate for the monofill area assumes that no ash emissions occur from the monofill surface due to wind erosion. The ash emissions that occur when the truck dumps the ash into monofill was estimated at 0.13 lb/day. The estimated emissions for the monofill maintenance activities were estimated to range from 0.3 lb/day based on the screening analysis assumptions to zero based on the refined analysis assumptions (which assumed an equivalent 20 percent ash moisture content). Although OHA has stated that the ash moisture content would be maintained at approximately 20 percent, OHA did not guarantee a 20 percent moisture content. Therefore, the higher fugitive ash emission rate (0.43 lb/day) was used in the air quality modeling assessment.

The Task Force believes that the fugitive emission rates as calculated by the AP-42 equations would vary due to a range of handling practices and environmental factors. Therefore, without any real empirical data available and with the extremely small quantities involved, uncertainties remain in the fugitive ash emission rate.

If OHA operates and maintains the ash handling facilities as described in the Stipulation of Conditions agreement, the Task Force expects that the fugitive ash emissions from the monofill area should be negligible. The Task Force also believes that the divergent risk estimates between both parties stem from errors contained in the risk assessment analysis and not in the difference in the estimate of the fugitive ash emissions.

As part of the negotiations that led to the Task Force study, OHA agreed to conduct a short-term ambient monitoring program using a sufficient number of particulate samplers spaced around the perimeter of the ash monofill to attempt to quantify the emissions from the monofill activities. The monitoring program must include meteorological measurements and enough monitors to determine the "upwind" and "downwind" concentrations for a given sampling period. The monitoring program should be specifically designed to enable the determination of a pollutant-specific emission rates. A monitoring protocol should be prepared and submitted to the DEQE for approval before start-up.

4.3 Summary and Conclusions for Task 3

At the beginning of this study, OHA data from an existing on-site meteorological monitoring program was mentioned to be available and forthcoming for comparison with the Logan Airport data used in the air quality and health risk assessments. An existing on-site meteorological monitoring program was reported to consist of a portable meteorological installation located on the roof of the existing RDF processing building. As such, the Task Force judged the meteorological data from this installation to be unacceptable for this study due to the likelihood that building wake effects have influenced the data.

In addition, the Task Force determined that a short-term meteorological monitoring program (during the course of this study) would not provide an adequate data record to compare local meteorological data with the Logan Airport data.

The U.S. EPA recognizes that to require each new source applicant to install a meteorological monitoring system before construction commences would impose a severe burden on development. For this reason, U.S. EPA allows the use of five years of off-site meteorological data in the air quality analysis, provided the data are reasonably representative of conditions at the plant site.

The U.S. EPA's modeling guideline [38] is clear in stating that on-site meteorological data (if available) are preferred for use in air quality modeling analyses. However, the use of a five year off-site data record (instead of a one year on-site database) allows for a greater number of combinations of meteorological conditions to provide that probable "worst-case" conditions would be reflected in the air quality modeling results.

In the air quality modeling assessment conducted in 1986 for the proposed OHA facility [1], five years (1979-1983) of meteorological data from Logan Airport data were used. The maximum annual average concentration due to stack emissions at the OHA facility for the five year period was calculated for 1979. The maximum annual average concentration for 1979 was determined to be 37 percent higher than the maximum annual average concentration for 1983. A study conducted with a 17-year data set found that the variability of model estimates due to meteorological data record length was adequately reduced if a five year period of meteorological data was used [38].

For stack emissions, the Logan Airport meteorological data appear reasonably representative of the Haverhill area. Any differences in meteorological conditions between the OHA site and Logan Airport should not result in significant differences in predicted air quality impacts, considering the length of the meteorological data base employed. The use of five years of meteorological data should provide that the worst-case meteorological conditions for the site were represented.

The Task Force requested that OHA's consultant conduct a modeling study [37] of the ash emission sources at the monofill. The purpose of the study was to rank hourly contributions to the overall annual average value by time of day, stability class, and wind speed. The annual average ISCST modeling results were computed using the 1983 Logan Airport meteorological data for all hours, daytime hours (8:00 a.m. to 7:00 p.m.) and nighttime hours (8:00 p.m. to 7:00 a.m.). The results (as shown in Table 3-18) indicate that the nighttime hours contribute the most to the annual average concentration. For the Spring Hill Farm, Crystal Lake, and maximum exposed individual (MEI) receptors, the 12-hour nighttime period is responsible for approximately 64 to 78 percent of the total annual average concentrations.

A major concern regarding the modeling of monofill emissions using the Logan Airport meteorological data is whether or not the effects of terrain channeling near the OHA site are taken into account. The data comparison does not provide assurance that the occurrence of winds under stable conditions and low wind speeds are represented to the extent they might occur in the Merrimack River valley. Since no nighttime observations were taken at Lawrence Airport, a complete evaluation of the similarities and differences between the two data bases could not be conducted.

The analysis of the Lawrence Airport data versus Logan Airport data does not conclusively put this issue to rest. As a meteorological program will be required to meet the monitoring requirements of Task 5, the Task Force recommends that this program be of sufficient quality and quantity to be of use in future air quality modeling, as required by DEQE. This program should obtain data representative of the conditions influencing fugitive ash emissions from the monofill as well as as conditions at stack height. The collection of stack-top meteorological data is necessary for use in analyzing the ambient air quality monitoring data to be collected as part of the Task 5 requirements. A meteorological monitoring protocol should be prepared and submitted to the DEQE for review and approval. Under the provisions of M.G.L. c.21H, DEQE requires the emission testing of resource recovery facilities and modeling emissions to determine impacts. The meteorological data obtained in Task 5 should be used in this analysis.

4.4 Summary and Conclusions for Task 4

The Task Force reviewed the interactive modeling analyses prepared by OHA for the two other resource recovery facilities identified in the Haverhill area. For the Ogden-Lawrence RDF and North Andover NESWC facilities, air dispersion models were used to estimate ambient air quality concentrations and deposition rates due to pollutant emission from each facility. The air quality modeling results were used in risk assessment studies conducted for each facility to estimate the health risk to human receptors.

In order to evaluate the appropriateness of the emissions data and modeling procedures used by OHA for the two existing facilities in the Haverhill area, the pollutant emission rates and stack parameters were compared with recent compliance testing results and facility information obtained from the Massachusetts DEQE.

Specific pollutant emission rates were determined by OHA's consultants for the Ogden-Lawrence and North Andover facilities from available stack sampling data and using scaling factors developed for pollutants for which no test data were available at the time of the study. Based on recent stack sampling tests conducted at both facilities in 1988, the DEQE summarized the results in a format suitable for use in an air quality modeling study.

The stack parameters used in the air quality modeling analyses conducted by OHA for the Lawrence and North Andover facilities were nearly identical to the values determined by the Task Force. Although no computer print-outs of the air quality modeling runs were presented in the Record for review and verification, it appears that correct stack parameters were used by OHA for the two existing facilities.

For the Ogden-Lawrence RDF facility, the trace metal emission rates obtained from the stack compliance tests were, in general, higher than the emission rates used by OHA in the health risk assessment. Emissions of chromium VI were measured to be over 250 times higher than the emission rate calculated by scaling the chromium VI emission rate used in the OHA stack risk assessment. Arsenic was not detected during the stack sampling tests conducted at the Lawrence facility. Therefore, a comparison between actual and estimated emissions cannot be performed. The 2,3,7,8 TCDD toxic equivalents emission rate calculated from the recent compliance tests at the Lawrence facility were found to be approximately 10 percent lower than the level used in the risk assessment conducted by OHA for the Lawrence facility.

For the North Andover NESWC facility, the emission rate of arsenic based on the stack sampling tests was found to be approximately five times higher than the emission rate calculated by OHA using the scaling factor approach. However, the emission rates of nickel and lead were found to be more than two times lower than the values used in the health risk assessment analysis conducted for the NESWC facility. Arsenic was not detected during the stack sampling tests conducted at the Lawrence facility. The 2,3,7,8 TCDD toxic equivalents emission rate calculated from the recent compliance tests at the North Andover facility were found to be approximately six times lower than the value used in the health risk assessment conducted for the NESWC facility.

In summary, the trace metal emission rates calculated from the recent compliance tests conducted at the existing facilities are, in general, higher than the emission rates used by OHA in the air quality and health risk assessment analyses conducted for each facility. However, the 2,3,7,8 TCDD toxic equivalents emission rates measured by the compliance tests at each facility are less than the emission rates used by OHA in its health risk assessment with the 2,3,7,8 TCDD toxic equivalents emission rate measured at the NESWC facility more than six times lower than the value used by OHA.

Besides the differences in the emission rates at the two facilities, the Task Force found that the stack health risk assessments analyses conducted by OHA for the Ogden-Lawrence and North Andover facilities still contain a number of unresolved technical issues. The health risk assessment for the two existing facilities was completed in November 1987. As with the stack risk assessment for the OHA facility, the Board's consultant disagreed with the approach used and results obtained by OHA's consultants. In particular, the deposition velocities used in the health risk assessment for the existing facilities do not appear to be consistent with the values used in the latest health risk assessment for the OHA facility.

The total lifetime cancer risk in Haverhill from stack emissions from the Ogden Lawrence RDF and North Andover NESWC facilities were calculated by OHA to be less than one in a million for the Lawrence and more than two in a million for the North Andover facility. The combined total lifetime cancer risk in Haverhill from stack emissions from both facilities was calculated by OHA to be less than three in a million with the location of the maximum exposed individual not stated.

In reviewing the OHA analyses, the Board's consultants disagreed with the results and corrected the risk calculations to account for errors common to the stack health risk assessment from the OHA facility. The Board's consultant estimated a lifetime cancer risk in the Haverhill area of three in a million due to the Lawrence facility and between 11 to 22 in a million for the North Andover facility. The differences between the two health risk estimates made by the Board's and OHA's consultants were due to the following technical issues:

- o Half-life of dioxins/furans in soil
- o Deposition rates of trace metals and organics
- o Bioconcentration factors in fish
- o Mothers' milk contributions for inorganics

Given that several technical issues in the health risk assessment analysis for the Lawrence and North Andover facilities were never resolved, it is not possible for the Task Force to extrapolate the findings on the actual stack emissions data (based on the compliance tests) to the stack health risk conclusions found in the Record. Additionally, further interactive air quality modeling was judged not to be of any use given the problems with the health risk assessment analysis.

What can be said is that the effects of dioxin half-life, reduced arsenic potency and lower dioxin emissions as identified in Task 1 will lower the risk while higher emissions will tend to increase the health risk.

If the Board feels that it is important to follow through and complete the health risk assessment for the two existing facilities, the Task Force recommends that OHA conduct an additional stack health risk assessment after the following information has been obtained and technical issues resolved:

- o Stack emissions data based on the compliance tests conducted at the Ogden-Lawrence and North Andover NESWC facilities should be used (unless more recent test data is available).
- o The deposition modeling approach should be consistent with the method used for the OHA stack evaluation.
- o The assumptions and approach for the health risk assessment for the two existing facilities should be consistent with the assumption and approach used for the OHA stack health risk assessment.

As an alternative approach to this issue, Task 5 which was developed in response to paragraph 4 of the December 13, 1988 Agreement requires a one year study of background ambient air levels and meteorology. This program will measure air quality in the Haverhill area of the Merrimack River valley for emissions of those contaminants of concern in the health risk assessments, including contributions from the Lawrence, North Andover, and Haverhill facilities.

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APPENDIX A

December 13, 1988 Agreement

AGREEMENT

THIS AGREEMENT is entered into this 13 day of December, 1988, among the Department of Environmental Quality Engineering for the Commonwealth of Massachusetts ("DEQE"), the Board of Health for the City of Haverhill ("the Board"), Refuse Fuels Associates ("RFA") and Ogden Haverhill Associates ("OHA"). This Agreement establishes a procedural protocol for the collection, evaluation and reporting of technical information under the supervision of DEQE at the joint request of the Board, RFA and OHA. All final written reports produced pursuant to this protocol will be made available to the Board, RFA and OHA for use in connection with the Board's review of the site assignment of OHA for the operation of a mass burn solid waste disposal, resource recovery and electric generating facility located on a site known as Ward Hill Neck in Haverhill, Massachusetts (the "mass burn facility") pursuant to M.G.L. c.111, §150A.

I. DEQE will supervise a technical review to address the following five specific questions utilizing existing qualified technical personnel of DEQE and through its existing contractual arrangements with the University of Massachusetts, pursuant to a Task Order entered into with the Environmental Institute of the University of Massachusetts (Amherst) under the direction of Dr. Joseph Larson, Director (the "Task Force"). In answering these questions, the Task Force shall receive technical data from OHA

and the Board and shall collect such relevant technical data as are presently available to DEQE from its existing database or otherwise reasonably obtainable from other sources as necessary to provide independent, scientifically-valid answers to the questions. The monitoring and testing to be undertaken by OEA as required hereunder shall be performed pursuant to the scope of work contained in Supplement 1 attached hereto.

II. The five technical questions are:

A. Evaluate OEA's stack emission data used in performing an air Health Risk Assessment ("air HRA") by reviewing (1) the Joy/Niro Report and supporting materials on recently concluded dioxin air emission testing of the Zurich Josefstrasse facility, in Zurich, Switzerland; (2) recent dioxin air emission data with respect to the Millbury, Massachusetts mass-burn facility with such technical adjustments as are necessary to ensure that the Millbury data are comparable to the OEA mass burn facility; and (3) any other relevant air emission data as has been collected by DEQE or is otherwise reasonably obtainable by the Task Force.

B. Evaluate OEA's ash emission data used in OEA's screening level and refined ash HRA's through the use of such actual fugitive emission data as exists in (1) a DEQE databank on ash emissions created in conjunction with the New York State Energy Research and Development Authority and the United States Environmental Protection Agency; (2) ash emission data which may

become available to DEQE during the course of this project along with such extrapolation and adjustments as are necessary to render these data comparable to the OHA mass-burn facility including those adjustments necessary to reflect OHA's ash management techniques reflected in a certain Stipulation of Conditions of December 13, 1988 to amend by stipulation the OHA site assignment; and (3) any other data, including data, if any, collected pursuant to Section III infra, as the Task Force shall deem available, comparable and scientifically reliable.

C. Evaluate the appropriateness of originally using Logan meteorological data in the ash and air HRA's submitted by OHA to the Board in connection with the site assignment hearing by review of available local meteorological data, if any. If sufficient data do not exist for the purposes of this review, then the Task Force shall approve a protocol for monitoring local meteorological conditions to develop short-term data for the purpose of evaluating the use of Logan meteorological data. The Task Force shall review all such data. The Task Force shall perform a sensitivity analysis to describe the scientific significance attendant on any such short-term meteorological study.

D. Evaluate the appropriateness of the emissions data used by OHA for the modelling of emissions from the NESWEC facility and Lawrence RFA facility in the combined ash/air HRA prepared and submitted by OHA to the Board, by evaluation of emissions studies for those facilities prepared for and submitted to

DEQE, when those studies have been validated and released by DEQE and information with regard to the mass-burn facility developed under task A. Based on a review of actual emissions data, the Task Force may conduct further modeling.

E. Review the screening level ash ERA submitted to the Board. The review by the Task Force will include reviewing the OEA Supplemental Submittal of December 6, 1988 and such other documents as the Task Force shall deem appropriate.

III. In addition to such actual ash emissions data as the Task Force may collect pursuant to Section IIB above, in the event that the Task Force shall determine that a short-term ash fugitive emissions monitoring program would yield scientifically reliable and usable data, the Task Force shall develop a protocol for such a short-term ash monitoring program to be conducted by OEA, under the supervision of the Task Force, at another Ogden mass burn ash monofill.

IV. The Task Force shall develop protocols and supervise a one year on-site monitoring program to be carried out by OEA for ash and air emissions from the OEA mass-burn facility including such monitoring of local meteorology and background ambient air levels as the Task Force shall deem appropriate. Based on criteria developed by the Task Force, OEA shall propose a monitoring protocol for review and approval of the Task Force. The stack emissions monitoring shall be consistent with DEQE air emissions regulations and permit conditions. The result of all such monitoring shall be reported to DEQE, OEA, and the Board.

V. The composition of the Task Force, after review, shall be mutually agreed upon prior to the commencement of the study. The submittal of this information by DEQE to the Board in response to the five questions in Section II and as provided in Sections III and IV is without prejudice or waiver of any of OEA's rights to challenge, refute or contest such report in the context of any new hearing commenced by the Board pursuant to G.L. c.111, §150A in connection with a review of the site assignment at the Ward Hill Neck Facility. The record and proceedings of the hearing commenced in May, 1987 having been closed, the information shall be supplied to the Board for its use as available. Further proceedings with respect to the Facility, if any, shall be pursuant to a new §150A hearing, duly noticed and properly commenced.

This Agreement is an integral part of a Stipulation of Conditions of December 13, 1988 to amend by stipulation the conditions of the site assignment for the Ward Hill Neck facility at Haverhill, Massachusetts. In the event that the Stipulation of Conditions are not adopted by the Board, this Agreement shall

be null and void and of no force and effect.

This Agreement does not affect any of the statutory or regulatory obligations of DEQE.

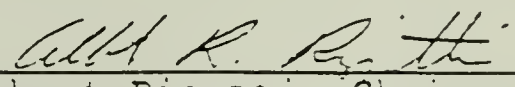
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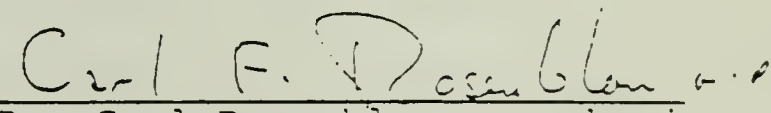

Daniel Greenbaum, Commissioner
One Winter Street
Boston, Massachusetts 02108

BOARD OF HEALTH, CITY OF
HAVERHILL

By:


Albert Rizotti, Chairman
as he is a member of the
Haverhill Board of Health

Ronald Albert, as he is a
member of the Haverhill
Board of Health


Dr. Carl Rosenbloom, as he is
a member of the Haverhill
Board of Health

OGDEN HAVERHILL ASSOCIATES

By:

Its:

December 13, 1988

REFUSE FUEL ASSOCIATES

By:

Its:

LETTER AGREEMENT

This Letter Agreement entered into this 15 day of December, 1988 by and between the Department of Environmental Quality Engineering for the Commonwealth of Massachusetts ("DEQE"), the Board of Health for the City of Haverhill (the "Board"), Refuse Fuels Associates ("RFA") and Ogden Haverhill Associates ("OHA").

The parties to this Letter Agreement entered into an Agreement dated December 13, 1988 pursuant to which they agreed to work with a Task Force which would include individuals from the University of Massachusetts (Amherst) to answer certain technical questions that have arisen during the course of a hearing held by the Board pursuant to M. G. L. c. 111, §150A regarding a site assignment for land located in Haverhill, Massachusetts. That Agreement provides that, "the composition of the Task Force, after review, shall be mutually agreed upon".

The parties wish to clarify that neither the Board nor OHA shall object to the composition of the Task Force established pursuant to the Agreement unless prior to making such objection, they have provided to DEQE, in writing, adequate notice of the specific person or persons to whom they do not consent, the basis of such determination and have demonstrated to the reasonable satisfaction of DEQE that DEQE should object to such person or persons pursuant to the terms of the contract currently in existence between the University of Massachusetts (Amherst) and DEQE. Furthermore, any such objection shall be limited solely to those types of objections which DEQE is

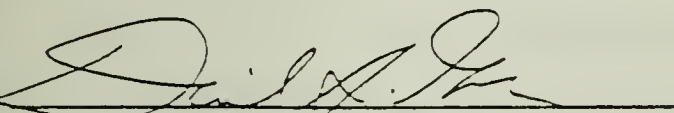
permitted to make pursuant to the terms of its current contract with the University of Massachusetts (Amherst).

The parties further agree that they shall not unreasonably withhold consent to the composition of any Task Force and that any refusal to agree to the composition of such a Task Force shall be limited solely to the manner and method as described within this Letter Agreement.

Notwithstanding the above, in the event of a dispute between DEQE and any of the other parties to this Agreement regarding the composition of the Task Force, the parties agree that DEQE and the University of Massachusetts (Amherst) shall be the sole arbiters of the composition of the Task Force, pursuant to the terms of their contract.

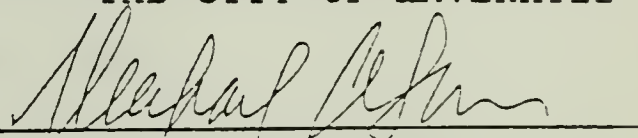
This instrument is executed as a sealed instrument this 15th day of December, 1988.

DEPARTMENT OF ENVIRONMENTAL
QUALITY ENGINEERING

By: 

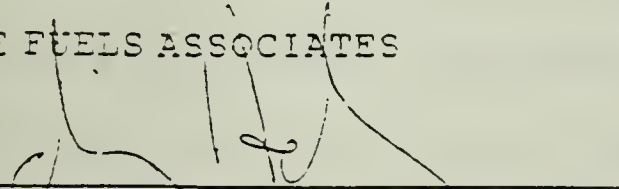
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THE BOARD OF HEALTH OF
THE CITY OF HAVERHILL

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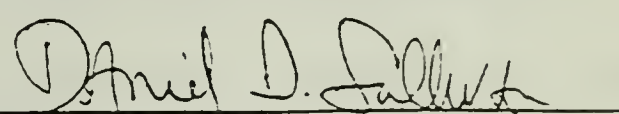
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SUPPLEMENT 1 TO AGREEMENT

OHA COMMITMENTS TO PROVIDE TECHNICAL SUPPORT TO THE TASK FORCE

I. OHA Services Under the Five Technical Questions

A. Obtain back-up reports on Zurich-Josefstrasse testing from Europe including specifications on waste stream, stoker/boiler and air pollution control equipment. Assist in obtaining other heavy metal and dioxin air emissions data from dry scrubber/ESP resource recovery facilities in the United States.

B. See III.

C. Supply and operate one Climatronics EWS electronic weather station to obtain wind speed, wind direction and temperature data for three (3) months.

D. Sigma Research Corporation will re-run screening level models with any new stack (i.e. flue gas) conditions to assess the impacts from the original modeling runs.

E. Sigma Research Corporation and Envirologic Data, Inc. will present their recent findings and answer questions.

II. OHA Services for Actual Ash Emission Data

If required by the Task Force to do short-term ash monitoring, OHA will develop and monitor one field scale simulation of ash dumping and burial at an Ogden mass-burn ash monofill for the direct measurement of any airborne particulate released therefrom. Both total particulate concentrations and particle size distribution data will be collected on a real time as well as

integrated basis. If required by the Task Force, OEA will repeat the exact same program at the OEA ash monofill during the first summer of its operation.

III. OEA Services for a One-Year On-Site Monitoring Program

Concurrent with the operation of the Climatronics EWS, a one-day (24-hours) sampling for TSP, selected heavy metals and dioxins and furans from a single monitor at a single on-site location will be performed each month for twelve (12) consecutive months. Cover soil and ash samples (one each) will be taken on each sampling day. Three (3) method blanks will be taken over the twelve (12) month program.

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JUN 6 1990

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CHARLESTOWN, MASS.

